

## 50 Multiple Choice Questions

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*Find the correct option:*

1) The units digit of the number  $17^{1983} + 11^{1983} - 7^{1983}$  is

- A) 3
- B) 1
- C) 9
- D) 2

2) If  $G$  is a cyclic group of order 24 and  $a^{2002} = a^n$  where  $a \in G$  and  $0 < n < 24$ . Then the value of  $n$  is

- A) 4
- B) 6
- C) 8
- D) 10

3) The ring  $\mathbb{Z}[x]$  is

- A) a PID
- B) a UFD
- C) a PID and a UFD
- D) none of these

4) Consider the matrix

$M = \begin{pmatrix} 3 & 0 & 0 \\ 0 & 2 & -5 \\ 0 & 1 & 2 \end{pmatrix}$  then

- A)  $M$  is diagonalizable over  $\mathbb{R}$ .
- B)  $M$  is diagonalizable over  $\mathbb{C}$ .
- C)  $M$  is not diagonalizable.
- D) none of these.

5) The system of linear equations

$2x+2y-3z=1, 4x+4y+z=2, 6x+6y-z=3$  has

- A) a unique solution
- B) infinite solutions
- C) no solution
- D) two solutions

6) The functional form of the linear transformation  $T$  from  $\mathbb{R}^2$  to itself whose matrix with respect to the basis  $\beta = \{(1,1), (1,-1)\}$  is

- A)  $\begin{pmatrix} 2 & 1 \\ 5 & 3 \end{pmatrix}$
- B)  $\begin{pmatrix} 2 & -1 \\ 3 & 5 \end{pmatrix}$
- C)  $\begin{pmatrix} 1 & -1 \\ 5 & 2 \end{pmatrix}$
- D)  $\begin{pmatrix} 3 & 5 \\ 2 & -1 \end{pmatrix}$

7) If  $T: \mathbb{R}^3 \rightarrow \mathbb{R}^3$  is defined by  $T(x,y,z) = (0,x,y)$ , then the nullity of  $T^2$  is

- A) 0

B) 1

C) 2

D) 3

8) Let  $f: X \rightarrow Y$  be an one-to-one map. Then which of the following is not correct?

A)  $X$  may be a subset of  $Y$

B)  $Y$  may be a subset of  $X$

C)  $X$  should be equal to  $Y$

D) cardinality of  $X$  should be equal to cardinality of  $Y$

9) Let  $g(x) = f(x) + f(1-x)$  and  $f'(x) < 0$  for all  $x \in (0, 1)$ . Then the interval in which  $g(x)$  is increasing is

A)  $(\frac{1}{2}, 1)$

B)  $(0, \frac{1}{2})$

C)  $(0, \frac{1}{2}) \cup (\frac{1}{2}, 1)$

D) none of these

10) Consider the function

$$f(x, y) = \begin{cases} \frac{x^3 - y^3}{x^2 - y^2}, & (x, y) \neq (0, 0) \\ 0, & (x, y) = (0, 0) \end{cases}$$

Choose the correct answer:

A)  $f$  is continuous, but not differentiable at the origin.

B)  $f$  is continuous and differentiable at the origin.

C)  $f_x(0, 0)$  and  $f_y(0, 0)$  exist, and  $f_x(0, 0) = f_y(0, 0)$ .

D)  $f_x$  and  $f_y$  are continuous at  $(0, 0)$ , and  $f_{xy}$  and  $f_{yx}$  do not exist.

11) Let  $f(x,y) = \begin{cases} xy \tan\left\{\frac{y}{x}\right\}, & (x,y) \neq (0,0) \\ 0, & (x,y) = (0,0) \end{cases}$

Choose the correct one

A)  $f_x + f_y + xy = 2f$

B)  $f_y + f_x = 2f$

C)  $f_x + f_y = 2f$

D)  $f_x - f_y = 2f$

12) The sequence  $\left\{\frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \dots, \frac{n}{n+1}\right\}$  is

A) monotonically increasing

B) increasing and bounded

C) non-increasing and bounded

D) non-increasing, but not bounded

13) Consider the following two statements:

(I) A complex valued function  $f(z) = u(x,y) + iv(x,y)$  is analytic in a region  $R$ .

(II)  $f(z)$  is such that  $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$  and  $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$  in a region  $R$ .

Choose the correct statement:

A) I and II are equivalent statements.

B) I does not imply II.

C) II implies I

D) II is necessary condition for I, but not sufficient in general.

14) Let  $\Gamma$  be the line segment joining  $0$  to  $1+i$ . Then the value of  $\int_{\Gamma} z dz$  is

- A)  $0$
- B)  $1+i$
- C)  $(1+i)^2$
- D)  $\frac{(1+i)^2}{2}$

15) Detect the wrong statement:

A) Let  $f(z)$  be continuous in a simply connected  $R$  and suppose that  $\oint_C f(z) dz = 0$  around every simple closed curve  $C$  in  $R$ . Then  $f(z)$  is a constant function.

B) If  $a$  and  $z$  are any two points in  $R$ , then  $\int_a^z f(z) dz$  is independent of the path in a region  $R$  joining  $a$  and  $z$ .

C) Let  $f(z)$  be analytic in the region bounded by non-overlapping simple closed curves  $C, C_1, C_2, \dots, C_n$  [where  $C_1, C_2, \dots, C_n$  are inside  $C$ ] and on these curves. Then

$$\oint_C f(z) dz = \oint_{C_1} f(z) dz + \oint_{C_2} f(z) dz + \dots + \oint_{C_n} f(z) dz.$$

D) The following result is always true

$$\left| \oint_C f(z) dz \right| \leq \int_C |f(z)| dz.$$

16) The solution of the equation  $\frac{d^2y}{dx^2} + y = 0$ , satisfying the condition  $y(0) = 1, y(\frac{\pi}{2}) = 2$  is

- A)  $\cos x + 2 \sin x$
- B)  $\cos x + \sin x$

C)  $2\cos x + \sin x$

D)  $2(\cos x + 2\sin x)$

17) The solution of the partial differential equation  $yzp + zxq = xy$  is given by

A)  $x^2 + y^2 = c_1$  and  $x^2 + z^2 = c_2$

B)  $x^2 - y^2 = c_1$  and  $x^2 - z^2 = c_2$

C)  $x^2 + y^2 = c_1$  and  $x^2 - z^2 = c_2$

D)  $x^2 - y^2 = c_1$  and  $x^2 + z^2 = c_2$

18) Given that  $y_1(x) = x^{-1}$  is one solution of  $2x^2y'' + 3xy' - y = 0, x > 0$ .

Then the second linearly independent solution is

A)  $x^{-2}$

B)  $x$

C)  $x^{\frac{1}{2}}$

D)  $x^2$

19) For the differential equation  $\frac{d^2y}{dx^2} + P(x)\frac{dy}{dx} + Q(x)y = 0, y = x^2$  is a partial integral if

A)  $1 - P + Q = 0$

B)  $Px + Qx^2 = 0$

C)  $2 + 2Px + Qx^2 = 0$

D)  $1 + P - Q = 0$

20) The solution of the partial differential equation  $xzp + yzq = xy$  is

A)  $\phi(x-y, y-z) = c_1$

B)  $\phi(xyz) = c_2$

C)  $\phi(xz, y) = c_3$

D)  $\phi(\frac{x}{y}, \frac{y}{z}) = c_4$

21) The moment of inertia of a rectangle of mass  $M$  and sides  $2a, 2b$  about a diagonal is

A)  $\frac{M}{5} \frac{a^2 b^2}{(a^2 + b^2)}$

B)  $\frac{M}{5} \frac{a^2 b^2}{(a^2 + b^2)}$

C)  $\frac{M}{3} \frac{a^2 b^2}{(a^2 + b^2)}$

D) none of these

22) The product of inertia of uniform rectangular lamina  $2a \times 2b$  about a pair of axes at its C.G. parallel to its edge is

A)  $\frac{1}{3} Mab$

B)  $0$

C)  $Mab$

D)  $\frac{1}{3} Ma^2 b^2$

23) The moment of inertia of a cube of edge  $2a$  and mass  $M$  about a line through its centre is

A)  $\frac{2}{5} Ma^2$

B)  $\frac{2}{3} Ma^2$

C)  $\frac{1}{3} Ma^2$

D)  $\frac{1}{2} Ma^2$

24) A system consisting of two particles moves on a plane. Then the degree of freedom is

- A) 2
- B) 3
- C) 4
- D) 6

25) For a conservative holonomic dynamical system, the Lagrangian  $L$ , kinetic energy  $T$  and potential energy  $V$  are connected by

- A)  $L=T+V$
- B)  $L=T-V$
- C)  $L=2T+V$
- D)  $L=2T-V$

26) Kinematics is concerned with

- A) the physical causes of the motion.
- B) the condition under which no motion is apparent
- C) the geometry of the motion
- D) none of these

27) The angular momentum  $\vec{\Omega}$  and the external torque  $\vec{\Lambda}$  of a rigid body about a point is connected by

- A)  $\frac{d\vec{\Omega}}{dt}=\vec{\Lambda}$



B)  $\frac{d\overrightarrow{\Lambda}}{dt} = \overrightarrow{\Omega}$

C)  $\frac{1}{2} \frac{d\overrightarrow{\Omega}}{dt} = \overrightarrow{\Lambda}$

D)  $\frac{1}{2} \frac{d\overrightarrow{\Lambda}}{dt} = \overrightarrow{\Omega}$

28) The directional derivative of  $f(x,y,z) = x^2yz + 4xz^2$  at the point  $(1, -2, -1)$  in the direction of  $2\hat{i} - \hat{j} - 2\hat{k}$  is

A)  $\frac{37}{3}$

B)  $-\frac{37}{3}$

C)  $\frac{1}{3}$

D) none of these

29) A unit vector normal to the surface  $z = x^2 + y^2$  at the point  $(-1, -2, 5)$  is

A)  $\frac{2\hat{i} - 4\hat{j} + \hat{k}}{\sqrt{21}}$

B)  $-2 \frac{2\hat{i} - 4\hat{j} + \hat{k}}{\sqrt{21}}$

C)  $2 \frac{2\hat{i} + 4\hat{j} + \hat{k}}{\sqrt{21}}$

D)  $2 \frac{2\hat{i} + 4\hat{j} - \hat{k}}{\sqrt{21}}$

30) If  $\phi = (x^2 + y^2 + z^2)^{-\frac{1}{2}}$ , then the value of  $\nabla \cdot \nabla \phi$  at all points except  $(0, 0, 0)$  is

A) 0

B) 1

C) 3

D) -2

31) The vector  $\vec{f} = (x+3y)\widehat{i} + (y-2z)\widehat{j} + (x+az)\widehat{k}$  is solenoidal. Then the value of  $\text{div } \vec{f}$  is

- A) 2
- B) 1
- C) 0
- D) -2

32) If  $v = |\vec{r}|$  where  $\vec{r} = x\widehat{i} + y\widehat{j} + z\widehat{k}$ , then  $\vec{\nabla} r^n$  equals

- A)  $r^{n-1}\vec{r}$
- B)  $r^{n-2}\vec{r}$
- C)  $r^n\vec{r}$
- D)  $r^{n+1}\vec{r}$

33) The directional derivative of  $\phi = xyz$  at the point  $(1,1,1)$  in the direction of  $\widehat{i}$  is

- A) -1
- B) 0
- C) 1
- D) 2

34) The Fourier sin transform of  $x^{m-1}$  is defined by

- A)  $\int_0^{\infty} x^{m-1} \sin sx \, dx$
- B)  $\int_{-\infty}^{\infty} x^{m-1} \sin sx \, dx$

C)  $\int_0^{\infty} x^{m-1} \sin x \, dx$

D)  $\int_{-\infty}^{\infty} x^{m-1} \sin x \, dx$

35) If  $L^{-1}\left\{\frac{1}{s}\right\}=1$  and  $L^{-1}\left\{\frac{1}{s^2}\right\}=t$ , then  $L^{-1}\left\{\frac{1}{s^3}\right\}$  is given by

A)  $\frac{1}{2t^2}$

B)  $-\frac{1}{2t^2}$

C)  $-\frac{t^2}{2}$

D)  $\frac{t^2}{2}$

36)  $L^{-1}\left\{\frac{1}{s^2-6s+10}\right\}$  equals

A)  $e^{3t} \cos t$

B)  $e^{-3t} \cos t$

C)  $e^{3t} \sin t$

D)  $e^{-3t} \sin t$

37)  $L\{\sin^2 at\}$  equals

A)  $\frac{2a^2}{s(s^2+4a^2)}$

B)  $\frac{2a^2}{s(s^2-4a^2)}$

C)  $\frac{2s}{s^2+4a^2}$

D) none of these

38) The first iterated kernel of the kernel  $k(x,t)=e^{x+t}$ ;  $a=0, b=1$  is given by

A)  $2e^{x+t}$

B)  $\frac{1}{2}e^{x+t}$

C)  $e^{x+t}$

D)  $(e^2-1)e^{x+t}$

39) The necessary condition for an admissible function to have an extremum of  $I[y(x)] = \int_{x_1}^{x_2} f(x, y, y') dx$  are

A)  $y(x_1) = y_1, y(x_2) = y_2$

B)  $y'(x)$  must be continuous

C)  $y''(x)$  must be continuous

D) All of these

40) In Simpson's  $\frac{1}{3}$ rd rule we replace the graph of the given function by some

A) second degree polynomials

B) third degree polynomials

C) fourth degree polynomials

D) fifth degree polynomials

41) The basis of polynomial interpretation is

A) Taylor's Theorem

B) Weierstrass Approximation Theorem

C) Rolle's Theorem

D) Mean Value Theorem

42) "Mathematical Expectation of the product of two random variables is equal to the product of their

expectations" is true for

- A) any two random variables.
- B) if the random variables are independent.
- C) if the covariance between the random variables is non zero.
- D) if the variance of the random variables are equal.

**43)** If a random variable  $X$  follows normal distribution with mean  $\mu$  and variance  $\alpha^2$  then the random variable  $Z = \frac{X - \mu}{\alpha}$  follows normal distribution with

- A) Mean = 1, variance = 0.
- B) Mean = 0, variance = 1.
- C) Mean =  $\frac{\mu}{2}$ , variance =  $\frac{\alpha^2}{4}$ .
- D) none of these

**44)** The number of real roots of the equation  $f(x) = 0$  on  $[a, b]$  equals the difference between the number of changes in sign Sturm sequence at  $x = a$  and  $x = b$  provided that

- A)  $f(a) = 0, f(b) \neq 0$
- B)  $f(a) = 0, f(b) = 0$
- C)  $f(a) \neq 0, f(b) \neq 0$
- D)  $f(a) \neq 0, f(b) = 0$

**45)** Let  $H = Z_2 \times Z_6$  and  $K = Z_3 \times Z_4$ . Then

- A)  $H \cong K$
- B)  $H \cong K$ , since  $Z_2, Z_3, Z_4$  and  $Z_6$  are cyclic.
- C)  $H$  and  $K$  are not isomorphic.

D)  $\mathbb{H}$  and  $\mathbb{K}$  are not isomorphic, since their identities are not equal.

[Hint:- The group  $\mathbb{K}$  is cyclic.]

46) Consider the group  $\mathbb{Z}_{495}$  under addition modulo 495.

(i)  $\{0, 99, 198, 307, 406\}$  is the unique subgroup of  $\mathbb{Z}_{495}$  of order 5.

(ii)  $\{0, 55, 110, 165, 220, 275, 330, 385, 440\}$  is the unique subgroup of  $\mathbb{Z}_{495}$  of order 9.

Then,

A) (i) is true, but (ii) is false

B) (ii) is true, but (i) is false

C) both (i) and (ii) are true

D) both (i) and (ii) are false

47) How many elements of order 5 are there in  $\mathbb{S}_7$  ?

A) 5

B) 21

C) 35

D) 33

48) Let  $f: \mathbb{R} \rightarrow \mathbb{R}$  and  $g: \mathbb{R} \rightarrow \mathbb{R}$  be continuous and  $f(x) = g(x) \forall x \in \mathbb{Q}$ . Then

A)  $f(x) = g(x)$  for some  $x \in \mathbb{R}/\mathbb{Q}$ .

B)  $f(x) = g(x) \forall x \in \mathbb{R}$ .

C)  $f(x) \neq g(x)$  for some  $x \in \mathbb{R}/\mathbb{Q}$ .

D)  $f(x) \neq g(x) \text{ for all } x \in \mathbb{R}/\mathbb{Q}$

[Hint:- For all  $a \in \mathbb{R}/\mathbb{Q}$  there exist  $x_n \in \mathbb{Q}$  such that  $x_n \rightarrow a$  ]

49) Following are three statements:

(i) Any n-dimensional real vector space is isomorphic to  $\mathbb{R}^n$ .

(ii) Any n-dimensional complex vector space is isomorphic to  $\mathbb{C}^n$ .

(iii) Any n-dimensional vector space over the field F is isomorphic to  $F^n$ .

Then

A) Only i and ii are true.

B) i is true, but ii and iii are not true.

C) None of them is true

D) All of them are true.

50) Following are two statements:

(i) Two finite-dimensional vector spaces over the same field are isomorphic.

(ii) Two finite-dimensional vector spaces over the same field and of the same dimension are isomorphic.

Then

A) i is true but ii is not true.

B) ii is true, but i is not true.

C) None of them is true

D) All of them are true.

**Answers:**

1) B , 2) D , 3) B , 4) \_\_ 5) B , 6) B , 7) \_\_ 8) C , 9) A , 10) \_\_

11) \_\_ 12) B , 13) \_\_ 14) D , 15) \_\_ 16) \_\_ 17) B , 18) C , 19) \_\_ 20) \_\_

21) \_\_ 22) \_\_ 23) B , 24) C , 25) B , 26) C , 27) A , 28) \_\_ 29) \_\_ 30) A ,

31) D , 32) B , 33) C , 34) A , 35) D , 36) C , 37) A , 38) C , 39) D , 40) \_\_

41) \_\_ 42) B , 43) B , 44) \_\_ 45) C , 46) C , 47) \_\_ 48) B , 49) D , 50) B.

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