MATRICES

USEFUL IN STUDY OF SCIENCE, ECONOMICS AND ENGINEERING

1. Definition : Rectangular array of mn numbers . Unlike determinants it has no value.

$$A = \begin{bmatrix} a_{11} & a_{12} & \ldots\ldots & a_{1n} \\ a_{21} & a_{22} & \ldots\ldots & a_{2n} \\ : & : & : & : \\ a_{m1} & a_{m2} & \ldots\ldots & a_{mn} \end{bmatrix} \quad \text{or} \quad \begin{pmatrix} a_{11} & a_{12} & \ldots\ldots & a_{1n} \\ a_{21} & a_{22} & \ldots\ldots & a_{2n} \\ : & : & : & : \\ a_{m1} & a_{m2} & \ldots\ldots & a_{mn} \end{pmatrix}$$

Abbreviated as : $A = \left[a_{ij}\right]$ $1 \le i \le m$; $1 \le j \le n$, i denotes the row and j denotes the column is called a matrix of order $m \times n$.

2. Special Type Of Matrices :

(a) Row Matrix : $A = [\,a_{11}, a_{12}, \ldots\ldots a_{1n}\,]$ having one row . $(1 \times n)$ matrix.
(or row vectors)

(b) Column Matrix : $A = \begin{bmatrix} a_{11} \\ a_{21} \\ : \\ a_{m1} \end{bmatrix}$ having one column. $(m \times 1)$ matrix
(or column vectors)

(c) Zero or Null Matrix : $(A = O_{m \times n})$
An $m \times n$ matrix all whose entries are zero .

$A = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$ is a 3×2 null matrix & $B = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ is 3×3 null matrix

(d) Horizontal Matrix : A matrix of order $m \times n$ is a horizontal matrix if $n > m$.

$$\begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 5 & 1 & 1 \end{bmatrix}$$

(e) Verical Matrix : A matrix of order $m \times n$ is a vertical matrix if $m > n$. $\begin{bmatrix} 2 & 5 \\ 1 & 1 \\ 3 & 6 \\ 2 & 4 \end{bmatrix}$

(f) Square Matrix : (Order n)

If number of row = number of column $\Rightarrow$ a square matrix.

Note (i) In a square matrix the pair of elements a_{ij} & a_{ji} are called **Conjugate Elements** .

e.g. $\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$

(ii) The elements $a_{11}, a_{22}, a_{33}, \ldots\ldots a_{nn}$ are called **Diagonal Elements** . The line along which the diagonal elements lie is called **"Principal or Leading"** diagonal.

The qty $\Sigma\, a_{ii}$ = trace of the matrice written as , i.e. $t_r A$

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Square Matrix

Triangular Matrix

$A = \begin{pmatrix} 1 & 3 & -2 \\ 0 & 2 & 4 \\ 0 & 0 & 5 \end{pmatrix}$; $B = \begin{pmatrix} 1 & 0 & 0 \\ 2 & -3 & 0 \\ 4 & 3 & 3 \end{pmatrix}$

Upper Triangular: $a_{ij} = 0 \ \forall \ i > j$

Lower Triangular: $a_{ij} = 0 \ \forall \ i < j$

Note that : Minimum number of zeros in a triangular matrix of order n = n(n–1)/2

Diagonal Matrix denote as $d_{dia}(d_1, d_2, \ldots, d_n)$ all elements except the leading diagonal are zero

diagonal Matrix: $\begin{bmatrix} d_1 & 0 & 0 \\ 0 & d_2 & 0 \\ 0 & 0 & d_3 \end{bmatrix}$

Unit or Identity Matrix: $a_{ij} = \begin{bmatrix} 1 & \text{if} & i = j \\ 0 & \text{if} & i \neq j \end{bmatrix}$

Note: (1) If $d_1 = d_2 = d_3 = a$ Scalar Matrix

(2) If $d_1 = d_2 = d_3 = 1$ Unit Matrix

Note: Min. number of zeros in a diagonal matrix of order n = n(n – 1)

"It is to be noted that with square matrix there is a corresponding determinant formed by the elements of A in the same order."

3. Equality Of Matrices :

Let $A = [a_{ij}]$ & $B = [b_{ij}]$ are equal if ,

(i) both have the same order . **(ii)** $a_{ij} = b_{ij}$ for each pair of i & j.

4. Algebra Of Matrices :

Addition : $A + B = \left[a_{ij} + b_{ij}\right]$ where A & B are of the same type. (same order)

(a) Addition of matrices is commutative.

i.e. $A + B = B + A$ $A = m \times n$; $B = m \times n$

(b) Matrix addition is associative .

$(A + B) + C = A + (B + C)$ **Note :** A, B & C are of the same type.

(c) Additive inverse.

If $A + B = \mathbf{O} = B + A$ $A = m \times n$

5. Multiplication Of A Matrix By A Scalar :

If $A = \begin{bmatrix} a & b & c \\ b & c & a \\ c & a & b \end{bmatrix}$; $kA = \begin{bmatrix} ka & kb & kc \\ kb & kc & ka \\ kc & ka & kb \end{bmatrix}$

6. Multiplication Of Matrices : (Row by Column)

AB exists if, $A = m \times n$ & $B = n \times p$

2×3 3×3

AB exists, but BA does not $\Rightarrow AB \neq BA$

Note : In the product AB , $\begin{cases} A = \text{pre factor} \\ B = \text{post factor} \end{cases}$

$A = (a_1, a_2, \ldots\ldots a_n)$ & $B = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{bmatrix}$

$1 \times n$ $n \times 1$

$AB = [a_1 b_1 + a_2 b_2 + \ldots\ldots + a_n b_n]$

If $A = \left[a_{ij}\right]$ $m \times n$ & $B = \left[b_{ij}\right]$ $n \times p$ matrix , then $(AB)_{ij} = \sum_{r=1}^{n} a_{ir} \cdot b_{rj}$

Properties Of Matrix Multiplication :

1. Matrix multiplication is not commutative.

$$A = \begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix} ; \quad B = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} ; AB = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} ; \quad BA = \begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix}$$

$\Rightarrow AB \neq BA$ (in general)

2. $AB = \begin{bmatrix} 1 & 1 \\ 2 & 2 \end{bmatrix} \begin{bmatrix} -1 & 1 \\ 1 & -1 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \quad \Rightarrow AB = \mathbf{O} \not\Rightarrow A = \mathbf{O}$ or $B = \mathbf{O}$

Note: If A and B are two non- zero matrices such that $AB = \mathbf{O}$ then A and B are called the divisors of zero.
Also if $[AB] = \mathbf{O} \Rightarrow |AB| \Rightarrow |A||B| = 0 \Rightarrow |A| = 0$ or $|B| = 0$ but not the converse.
If A and B are two matrices such that
(i) $AB = BA \Rightarrow$ A and B commute each other
(ii) $AB = -BA \Rightarrow$ A and B anti commute each other

3. Matrix Multiplication Is Associative :
If A, B & C are conformable for the product AB & BC, then

$$(A . B) . C = A . (B . C)$$

4. Distributivity :

$$\left.\begin{array}{l} A(B + C) = AB + AC \\ (A + B)C = AC + BC \end{array}\right]$$ Provided A, B & C are conformable for respective products

5. Positive Integral Powers Of A Square Matrix :
For a square matrix A, $A^2A = (AA)A = A(AA) = A^3$.
Note that for a unit matrix I of any order, $I^m = I$ for all $m \in N$.

6. MATRIX POLYNOMIAL :
If $f(x) = a_0x^n + a_1x^{n-1} + a_2x^{n-2} + ... + a_nx^0$ then we define a matrix polynomial
$f(A) = a_0A^n + a_1A^{n-1} + a_2A^{n-2} + ... + a_nI^n$
where A is the given square matrix. If f(A) is the null matrix then A is called the zero or root of the polynomial f(x).

DEFINITIONS :

(a) **Idempotent Matrix :** A square matrix is idempotent provided $A^2 = A$.
Note that $A^n = A \ \forall \ n \geq 2, n \in N$.

(b) **Nilpotent Matrix:** A square matrix is said to be nilpotent matrix of order m, $m \in N$, if $A^m = \mathbf{O}, A^{m-1} \neq \mathbf{O}$.

(c) **Periodic Matrix :** A square matrix is which satisfies the relation $A^{K+1} = A$, for some positive integer K, is a periodic matrix. The period of the matrix is the least value of K for which this holds true.
Note that period of an idempotent matrix is 1.

(d) **Involutary Matrix :** If $A^2 = I$, the matrix is said to be an involutary matrix.
Note that $A = A^{-1}$ for an involutary matrix.

7. The Transpose Of A Matrix : (Changing rows & columns)
Let A be any matrix. Then, $A = a_{ij}$ of order $m \times n$
$\Rightarrow A^T$ or $A' = [a_{ji}]$ for $1 \leq i \leq n$ & $1 \leq j \leq m$ of order $n \times m$

Properties of Transpose : If A^T & B^T denote the transpose of A and B,
(a) $(A \pm B)^T = A^T \pm B^T$; note that A & B have the same order.
IMP. (b) $(AB)^T = B^T A^T$ A & B are conformable for matrix product AB.
(c) $(A^T)^T = A$
(d) $(kA)^T = kA^T$ k is a scalar.

General : $(A_1, A_2, ... A_n)^T = A_n^T, ..., A_2^T, A_1^T$ (reversal law for transpose)

8. Symmetric & Skew Symmetric Matrix :

A square matrix $A = [a_{ij}]$ is said to be ,

symmetric if,

$a_{ij} = a_{ji} \quad \forall \; i \;\&\; j$ (conjugate elements are equal) **(Note $A = A^T$)**

Note: Max. number of distinct entries in a symmetric matrix of order n is $\frac{n(n+1)}{2}$.

and skew symmetric if,

$a_{ij} = -a_{ji} \quad \forall \; i \;\&\; j$ (the pair of conjugate elements are additive inverse of each other) **(Note $A = -A^T$)**

Hence If A is skew symmetric, then

$$a_{ii} = -a_{ii} \Rightarrow a_{ii} = 0 \quad \forall \; i$$

Thus the digaonal elements of a skew symmetric matrix are all zero , but not the converse .

Properties Of Symmetric & Skew Matrix :

P – 1 A is symmetric if $A^T = A$

A is skew symmetric if $A^T = -A$

P – 2 $A + A^T$ is a symmetric matrix

$A - A^T$ is a skew symmetric matrix .

Consider $(A + A^T)^T = A^T + (A^T)^T = A^T + A = A + A^T$

$A + A^T$ is symmetric .

Similarly we can prove that $A - A^T$ is skew symmetric .

P – 3 The sum of two symmetric matrix is a symmetric matrix and the sum of two skew symmetric matrix is a skew symmetric matrix .

Let $A^T = A$; $B^T = B$ where A & B have the same order .

$\mathbf{(A + B)^T = A + B}$

Similarly we can prove the other

P – 4 If A & B are symmetric matrices then ,

(a) AB + BA is a symmetric matrix

(b) AB – BA is a skew symmetric matrix .

P – 5 Every square matrix can be uniquely expressed as a sum of a symmetric and a skew symmetric matrix.

$$A = \underbrace{\frac{1}{2}(A + A^T)}_{\substack{P \\ \text{Symmetric}}} + \underbrace{\frac{1}{2}(A - A^T)}_{\substack{Q \\ \text{Skew Symmetric}}}$$

9. Adjoint Of A Square Matrix :

Let $A = [a_{ij}] = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}$ be a square matrix and let the matrix formed by the cofactors of $[a_{ij}]$ in determinant $|A|$ is $= \begin{pmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{pmatrix}$.

Then $(\text{adj } A) = \begin{pmatrix} C_{11} & C_{21} & C_{31} \\ C_{12} & C_{22} & C_{32} \\ C_{13} & C_{23} & C_{33} \end{pmatrix}$

V. Imp. Theorem : $A(\text{adj. }A) = (\text{adj. }A).A = |A|\, I_n$, If A be a square matrix of order n.

Note : If A and B are non singular square matrices of same order, then

(i) $|\text{adj } A| = |A|^{n-1}$

(ii) $\text{adj }(AB) = (\text{adj } B)(\text{adj } A)$

(iii) $\text{adj}(KA) = K^{n-1}(\text{adj } A)$, K is a scalar

Inverse Of A Matrix (Reciprocal Matrix) :

A square matrix A said to be invertible (non singular) if there exists a matrix B such that,

$$AB = I = BA$$

B is called the inverse (reciprocal) of A and is denoted by A^{-1}. Thus

$$A^{-1} = B \Leftrightarrow AB = I = BA.$$

We have, $A.(\text{adj } A) = |A|\ I_n$

$$A^{-1} A\ (\text{adj } A) = A^{-1} I_n\ |A|$$

$$I_n\ (\text{adj } A) = A^{-1}\ |A|\ I_n$$

$$\therefore \quad A^{-1} = \frac{(\text{adj } A)}{|A|}$$

Note : The necessary and sufficient condition for a square matrix A to be invertible is that $|A| \neq 0$.

Imp. Theorem : If A & B are invertible matrices ofthe same order, then $(AB)^{-1} = B^{-1}A^{-1}$. This is reversal law for inverse.

Note :

(i) If A be an invertible matrix, then A^T is also invertible & $(A^T)^{-1} = (A^{-1})^T$.

(ii) If A is invertible, **(a)** $(A^{-1})^{-1} = A$; **(b)** $(A^k)^{-1} = (A^{-1})^k = A^{-k}, k \in N$

(iii) If A is an Orthogonal Matrix. $AA^T = I = A^TA$

(iv) A square matrix is said to be **orthogonal** if, $A^{-1} = A^T$.

(v) $|A^{-1}| = \dfrac{1}{|A|}$

SYSTEM OF EQUATION & CRITERIAN FOR CONSISTENCY

GAUSS - JORDAN METHOD

$$x + y + z = 6$$
$$x - y + z = 2$$
$$2x + y - z = 1$$

or
$$\begin{pmatrix} x+y+z \\ x-y+z \\ 2x+y-z \end{pmatrix} = \begin{pmatrix} 6 \\ 2 \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \\ 2 & 1 & -1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 6 \\ 2 \\ 1 \end{pmatrix}$$

$$AX = B \quad \Rightarrow \quad A^{-1}AX = A^{-1}B$$

$$X = A^{-1}B = \frac{(\text{adj. } A).B}{|A|}.$$

Note :

(1) If $|A| \neq 0$, system is consistent having unique solution

(2) If $|A| \neq 0$ & $(\text{adj } A) . B \neq \mathbf{O}$ (Null matrix), system is consistent having unique non–trivial solution.

(3) If $|A| \neq 0$ & $(\text{adj } A) . B = \mathbf{O}$ (Null matrix), system is consistent having trivial solution.

(4) If $|\mathbf{A}| = \mathbf{0}$, **matrix method fails**

- If $(\text{adj } A) . B =$ null matrix $= \mathbf{O}$ → Consistent (Infinite solutions)
- If $(\text{adj } A) . B \neq \mathbf{O}$ → Inconsistent (no solution)

EXERCISE-I

Q.1 If, $E=\begin{bmatrix}0&1&0\\0&0&1\\0&0&0\end{bmatrix}$ and $F=\begin{bmatrix}0&0&0\\1&0&0\\0&1&0\end{bmatrix}$ calculate the matrix product EF & FE and show that $E^2F+FE^2=E$.

Q.2 Find the number of 2×2 matrix satisfying

(i) a_{ij} is 1 or –1 ; (ii) $a_{11}^2+a_{12}^2=a_{21}^2+a_{22}^2=2$; (iii) $a_{11}\,a_{21}+a_{12}\,a_{22}=0$

Q.3 Find the value of x and y that satisfy the equations.

$$\begin{bmatrix}3&-2\\3&0\\2&4\end{bmatrix}\begin{bmatrix}y&y\\x&x\end{bmatrix}=\begin{bmatrix}3&3\\3y&3y\\10&10\end{bmatrix}$$

Q.4 Let $A=\begin{bmatrix}a&b\\c&d\end{bmatrix}$ and $B=\begin{bmatrix}p\\q\end{bmatrix}\neq\begin{bmatrix}0\\0\end{bmatrix}$. Such that AB = B and a + d = 5050. Find the value of (ad – bc).

Q.5 Define $A=\begin{bmatrix}0&1\\3&0\end{bmatrix}$. Find a vertical vector V such that $(A^8+A^6+A^4+A^2+I)V=\begin{bmatrix}0\\11\end{bmatrix}$ (where I is the 2×2 identity matrix).

Q.6 If, $A=\begin{bmatrix}1&0&2\\0&2&1\\2&0&3\end{bmatrix}$, then show that the maxtrix A is a root of the polynomial $f(x)=x^3-6x^2+7x+2$.

Q.7 For a non zero λ, use induction to prove that : (Only for XII CBSE)

(a) $$\begin{bmatrix}\lambda&1&0\\0&\lambda&1\\0&0&\lambda\end{bmatrix}^n=\begin{bmatrix}\lambda^n&n\lambda^{n-1}&\frac{n(n-1)}{2}\lambda^{n-2}\\0&\lambda^n&n\lambda^{n-1}\\0&0&\lambda^n\end{bmatrix},\ \text{for every } n\in N$$

(b) If, $A=\begin{bmatrix}0&1\\0&0\end{bmatrix}$, then $(aI+bA)^n=a^nI+na^{n-1}bA$, where I is a unit matrix of order 2, $\forall\ n\in N$.

Q.8 If the matrices $A=\begin{bmatrix}1&2\\3&4\end{bmatrix}$ and $B=\begin{bmatrix}a&b\\c&d\end{bmatrix}$ (a, b, c, d not all simultaneously zero) commute, find the value of $\frac{d-b}{a+c-b}$. Also show that the matrix which commutes with A is of the form $\begin{bmatrix}\alpha-\beta&2\beta/3\\\beta&\alpha\end{bmatrix}$

Q.9 If $\begin{bmatrix} a & b \\ c & 1-a \end{bmatrix}$ is an idempotent matrix. Find the value of f(a), where $f(x) = x - x^2$, when $bc = 1/4$. Hence otherwise evaluate a.

Q.10 If the matrix A is involutary, show that $\frac{1}{2}(I + A)$ and $\frac{1}{2}(I - A)$ are idempotent and $\frac{1}{2}(I+A)\cdot\frac{1}{2}(I-A)=\mathbf{O}$.

Q.11 Show that the matrix $A = \begin{bmatrix} 1 & 0 \\ 2 & 1 \end{bmatrix}$ can be decomposed as a sum of a unit and a nilpotent marix. Hence evaluate the matrix $\begin{bmatrix} 1 & 0 \\ 2 & 1 \end{bmatrix}^{2007}$.

Q.12 Given matrices $A = \begin{bmatrix} 1 & x & 1 \\ x & 2 & y \\ 1 & y & 3 \end{bmatrix}$; $B = \begin{bmatrix} 3 & -3 & z \\ -3 & 2 & -3 \\ z & -3 & 1 \end{bmatrix}$
Obtain x, y and z if the matrix AB is symmetric.

Q.13 Let X be the solution set of the equation $A^x = I$, where $A = \begin{bmatrix} 0 & 1 & -1 \\ 4 & -3 & 4 \\ 3 & -3 & 4 \end{bmatrix}$ and I is the corresponding unit matrix and $x \subseteq N$ then find the minimum value of $\sum(\cos^x\theta + \sin^x\theta)$, $\theta \in R$.

Q.14 $A = \begin{pmatrix} 3 & a & -1 \\ 2 & 5 & c \\ b & 8 & 2 \end{pmatrix}$ is Symmetric and $B = \begin{pmatrix} d & 3 & a \\ b-a & e & -2b-c \\ -2 & 6 & -f \end{pmatrix}$ is Skew Symmetric, then find AB.
Is AB a symmetric, Skew Symmetric or neither of them. Justify your answer.

Q.15 Express the matrix $\begin{bmatrix} 1 & 2 & 5 \\ 2 & 3 & -6 \\ -1 & 0 & 4 \end{bmatrix}$ as a sum of a lower triangular matrix & an upper triangular matrix with zero in its leading diagonal. Also Express the matrix as a sum of a symmetric & a skew symmetric matrix.

Q.16 A is a square matrix of order n.
l = maximum number of distinct entries if A is a triangular matrix
m = maximum number of distinct entries if A is a diagonal matrix
p = minimum number of zeroes if A is a triangular matrix
If $l + 5 = p + 2m$, find the order of the matrix.

Q.17 If A is an idempotent non zero matrix and I is an identity matrix of the same order, find the value of n, $n \in N$, such that $(A + I)^n = I + 127A$.

Q.18 Consider the two matrices A and B where $A = \begin{bmatrix} 1 & 2 \\ 4 & 3 \end{bmatrix}$; $B = \begin{bmatrix} 5 \\ -3 \end{bmatrix}$. If n(A) denotes the number of elements in A such that n(XY) = 0, when the two matrices X and Y are not conformable for multiplication. If C = (AB)(B'A); D = (B'A)(AB) then, find the value of $\left(\frac{n(C)\left(|D|^2 + n(D)\right)}{n(A) - n(B)}\right)$.

ANSWER KEY

EXERCISE-I

Q.1 EF = $\begin{bmatrix}1&0&0\\0&1&0\\0&0&0\end{bmatrix}$, FE = $\begin{bmatrix}0&0&0\\0&1&0\\0&0&1\end{bmatrix}$ Q.2 8 Q.3 $x = \frac{3}{2}$, $y = 2$

Q.4 5049 Q.5 V = $\begin{bmatrix}0\\ \frac{1}{11}\end{bmatrix}$

Q.8 1 Q.9 f (a) = 1/4, a = 1/2 Q.11 $\begin{bmatrix}1&0\\4014&1\end{bmatrix}$

Q.12 $\left(-\frac{4\sqrt{2}}{3}, \frac{2}{3}, 2\sqrt{2}\right), \left(\frac{4\sqrt{2}}{3}, \frac{2}{3}, -2\sqrt{2}\right)$,(3,3, –1) Q.13 2

Q.14 **AB is neither symmetric nor skew symmetric**

Q.15 $\begin{bmatrix}1&0&0\\2&3&0\\-1&0&4\end{bmatrix} + \begin{bmatrix}0&2&5\\0&0&-6\\0&0&0\end{bmatrix}; \begin{bmatrix}1&2&2\\2&3&-3\\2&-3&4\end{bmatrix} + \begin{bmatrix}0&0&3\\0&0&-3\\-3&3&0\end{bmatrix}$

Q.16 4 Q.17 n = 7 Q.18 650

EXERCISE-II

Q 1. Additive inverse of the matrix $\begin{bmatrix}1&0&2&-1\\3&4&8&12\end{bmatrix}$ is

(a) $\begin{bmatrix}3&4&8&12\\1&0&2&-1\end{bmatrix}$ (b) $\begin{bmatrix}-3&-4&-8&-12\\1&0&2&-1\end{bmatrix}$ (c) $\begin{bmatrix}-1&0&-2&1\\-3&-4&-8&-12\end{bmatrix}$

(d) not defined as it is not a square matrix.

Q 2. A matrix A = $[a_{ij}]_{n \times n}$ is said to be lower triangular if :
(a) a_{ij} = 0 for i > j (b) a_{ij} = 0 for i < j (c) a_{ij} = 0 for i ≥ j (d) a_{ij} = 0 for i d" j

Q 3. A matrix A = $[a_{ij}]_{m \times n}$ is said to be row matrix if :
(a) m = 1 (b) n = 1 (c) m = n (d) m ≠ n

Q 4. The product AB of the matrix A and B is possible if
(a) number of columns of A and B are equal
(b) number of rows of A and B are equal
(c) number of rows in A is equal to the number of columns in B
(d) number of columns in A is equal to number of rows in B

Q 5. If A is a matrix of order 2 × 3 and AB is the matrix of order 2 × 5, then B may be a :
(a) 3 × 5 matrix (b) 5 × 3 matrix (c) 3 × 2 matrix (d) 5 × 2 matrix

Q 6. $\begin{bmatrix} 1 & 2 & 4 \\ 2 & 0 & -1 \\ a & -3 & 2 \end{bmatrix}$ will be a singular matrix if a equals **(Concept of determinants)**:

(a) $\frac{35}{2}$ (b) $\frac{-35}{2}$ (c) 17 (d) – 17

Q 7. If $\begin{bmatrix} x+y & 8 \\ 0 & x-y \end{bmatrix} = \begin{bmatrix} 2 & 3 \\ -1 & 5 \end{bmatrix} + \begin{bmatrix} 3 & 5 \\ 1 & -2 \end{bmatrix}$ then (x, y) equals :

(a) (4, 1) (b) (1, 4) (c) (– 4, – 1) (d) (1, – 4)

Q 8. If $A = \begin{bmatrix} 0 & 2 & 3 \\ 2 & 1 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 7 & 6 & 3 \\ 1 & 4 & 5 \end{bmatrix}$ then 3A – 2B is the matrix :

(a) $\begin{bmatrix} -14 & 6 & -3 \\ 4 & 5 & -2 \end{bmatrix}$ (b) $\begin{bmatrix} 14 & -6 & -3 \\ -4 & -5 & -2 \end{bmatrix}$ (c) $\begin{bmatrix} -14 & -6 & 3 \\ 4 & -5 & 2 \end{bmatrix}$ (d) $\begin{bmatrix} 14 & 6 & -3 \\ 4 & 5 & -2 \end{bmatrix}$

Q 9. Which of the following matrix is not symmetric :

(a) $\begin{bmatrix} 4 & -8 \\ -8 & 4 \end{bmatrix}$ (b) $\begin{bmatrix} 5 & -6 & 1 \\ -6 & 3 & 0 \\ 1 & 0 & 8 \end{bmatrix}$ (c) $\begin{bmatrix} a & h & g \\ h & b & f \\ g & f & c \end{bmatrix}$ (d) $\begin{bmatrix} 5 & 4 & 3 \\ -4 & 0 & 1 \\ -3 & -1 & 0 \end{bmatrix}$

Q 10. Which of the following may be a skew symmetric matrix ($a_i \neq 0$) :

(a) $\begin{bmatrix} a_1 & a_2 \\ a_3 & a_4 \end{bmatrix}$ (b) $\begin{bmatrix} a_1 & 0 & 0 \\ 0 & a_2 & 0 \\ 0 & 0 & a_3 \end{bmatrix}$ (c) $\begin{bmatrix} 0 & a_1 & a_2 \\ a_3 & 0 & a_4 \\ a_5 & a_6 & 0 \end{bmatrix}$ (d) $\begin{bmatrix} a_1 & 1 & 2 \\ -1 & a_2 & 3 \\ -2 & -3 & a_3 \end{bmatrix}$

Q 11. If $A = \begin{bmatrix} 2 & 3 & 1 \\ 4 & -2 & 6 \end{bmatrix}$; $B = \begin{bmatrix} 0 & 3 & 2 \\ -2 & 1 & 4 \end{bmatrix}$ and $C = \begin{bmatrix} 7 & 8 \\ 9 & 0 \\ 6 & 5 \end{bmatrix}$ then $2A + 3B - C^T$ equals :

(a) $\begin{bmatrix} -3 & 6 & 2 \\ -6 & -1 & 19 \end{bmatrix}$ (b) $\begin{bmatrix} 3 & 6 & 2 \\ 6 & 1 & 19 \end{bmatrix}$ (c) $\begin{bmatrix} 11 & 24 & 14 \\ 10 & 7 & 31 \end{bmatrix}$ (d) not define

Q 12. If order of the matrix A is 3 × 5, then order the matrix A^2 is :
(a) 3 × 5 (b) 5 × 3 (c) 3 × 3 (d) None of these

Q 13. If A is square matrix of m × m then order of A^n is :
(a) n × n (b) m × m (c) m × n (d) n × m

Q 14. Which of the following is true, if A and B are square matrices of the same order :
(a) $(A + B)^2 = A^2 + B^2 + 2AB$ (b) $(A + B)(A - B) = A^2 - B^2$
(c) $(A + B)^2 + (A - B)^2 = 2A^2 + 2B^2$ (d) None of these

Q 15. If $A = \begin{bmatrix} 1 & 0 \\ 0 & i \end{bmatrix}$ then A^n is equal to ($i = \sqrt{-1}$)

(a) A for n = 4 (b) – A for n = 6 (c) – I for n = 5 (d) I for n = 8

Q 16. If P [x y z], Q = $\begin{bmatrix} a & h & g \\ h & b & f \\ g & f & c \end{bmatrix}$, R = $\begin{bmatrix} x \\ y \\ z \end{bmatrix}$ then $[ax^2 + by^2 + cz^2 + 2hxy + 2gzx + 2fyz]$ is :

(a) (QP)R (b) (PQ)R (c) (PR)Q (d) None of these

Q 17. If A = $\begin{bmatrix} \cos\alpha & \sin\alpha \\ \sin\alpha & \cos\alpha \end{bmatrix}$ then A^2 is given by :

(a) $\begin{bmatrix} 1 & \cos 2\alpha \\ \sin 2\alpha & 0 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & \sin 2\alpha \\ \sin 2\alpha & 1 \end{bmatrix}$ (c) $\begin{bmatrix} 1 & \cos 2\alpha \\ \cos 2\alpha & 1 \end{bmatrix}$ (d) None of these

Q 18. If A = $\begin{bmatrix} 3 & -3 \\ 1 & -1 \end{bmatrix}$, then A^n is equal to :

(a) $\begin{bmatrix} 3^n & (-4)^n \\ 1 & (-1)^n \end{bmatrix}$ (b) $\begin{bmatrix} 1+3n & 1-4n \\ 1+n & 1-n \end{bmatrix}$ (c) $\begin{bmatrix} 1+2n & -4n \\ 2n-2 & 1-2n \end{bmatrix}$ (d) $\begin{bmatrix} 1+2n & -4n \\ n & 1-2n \end{bmatrix}$

Q 19. If A = $\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$, then A^5 is :

(a) 4A (b) 5A (c) 8A (d) 16A

Q 20. If [1 x 1] $\begin{bmatrix} 2 & 3 & 2 \\ 0 & 5 & 1 \\ 0 & 3 & 2 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ x \end{bmatrix}$ = 0, then values of x are :

(a) 1, 8 (b) – 1, 8 (c) – 1, – 8 (d) 1, – 8

Q 21. If F(x) = $\begin{bmatrix} \cos x & -\sin x & 0 \\ \sin x & \cos x & 0 \\ 0 & 0 & 1 \end{bmatrix}$ then F(x + y) equals :

(a) F(x) F(y) (b) F(x) + F(y) (c) F(x) – F(y) (d) F(xy)

Q 22. If $\begin{bmatrix} 2 & -1 \\ 1 & 0 \\ -3 & 4 \end{bmatrix}$ A = $\begin{bmatrix} -1 & -8 & -10 \\ 1 & -2 & -5 \\ 9 & 22 & 15 \end{bmatrix}$ then matrix A is :

(a) $\begin{bmatrix} 1 & -2 & -5 \\ 3 & 4 & 0 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 3 \\ -2 & 4 \\ -5 & 0 \end{bmatrix}$ (c) $\begin{bmatrix} -1 & 2 & 5 \\ 3 & 4 & 0 \end{bmatrix}$ (d) None of these

Q 23. If A = $\begin{bmatrix} 1 & 0 \\ -1 & 7 \end{bmatrix}$ and $A^2 = 8A + kI_2$ then k equals :

(a) 1 (b) – 1 (c) 7 (d) – 7

Q 24. If A = $\begin{bmatrix} 3 & -5 \\ -4 & 2 \end{bmatrix}$ then $A^2 - 5A - 15I$ equals :

(a) $\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ (c) $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

Q 25. If $\begin{bmatrix} \cos^2\theta & \cos\theta\sin\theta \\ \cos\theta\sin\theta & \sin^2\theta \end{bmatrix}\begin{bmatrix} \cos^2\phi & \cos\phi\sin\phi \\ \cos\phi\sin\phi & \sin^2\phi \end{bmatrix}$ is zero matrix then θ and ϕ differ by

(a) even multiple of $\frac{\pi}{2}$ (b) Odd multiple of $\frac{\pi}{2}$ (c) even multiple of π (d) None of these

Q 26. $\begin{bmatrix} 1 \\ -2 \\ 3 \end{bmatrix} \times \begin{bmatrix} 4 & 5 & 2 \end{bmatrix} \times \begin{bmatrix} 2 \\ -3 \\ 5 \end{bmatrix} \times [3 \quad 2 \quad 1]$ is a matrix of order :

(a) 1 × 1 (b) 3 × 1 (c) 1 × 3 (d) 3 × 3

Q 27. The value of $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} \times \begin{bmatrix} 3 & 2 & 4 \end{bmatrix} \times \begin{bmatrix} 4 \\ 6 \\ 7 \end{bmatrix}$ equals :

(a) $\begin{bmatrix} 52 \\ -104 \\ 156 \end{bmatrix}$ (b) $\begin{bmatrix} 52 & -104 & 156 \end{bmatrix}$ (c) $\begin{bmatrix} 52 \\ 104 \\ 156 \end{bmatrix}$ (d) does not define

Q 28. If A = $\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$ and B = $\begin{bmatrix} 1 & 4 \\ 2 & 5 \end{bmatrix}$ then (AB) equals :

(a) $\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}\begin{bmatrix} 1 & 4 \\ 2 & 5 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 4 \\ 2 & 5 \end{bmatrix}$ (c) $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}\begin{bmatrix} 1 & 2 \\ 4 & 5 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 2 \\ 4 & 5 \end{bmatrix}$

Q 29. If A = $\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}$ and I is the unit matrix then $A^2 - 4A$ equals :

(a) 0 (b) I (c) 5I (d) 3I

Q 30. If ω be the cube root of unity then $\begin{bmatrix} \omega & -\omega^2 \\ 1 & \omega \\ \omega^2 & 1 \end{bmatrix} \times \begin{bmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & 1 \end{bmatrix} \times \begin{bmatrix} 1 \\ \omega \\ \omega^2 \end{bmatrix}$ equals :

(a) $\begin{bmatrix} \omega-\omega^2 \\ \omega-\omega^2 \\ \omega-2\omega^2 \end{bmatrix}$ (b) $\begin{bmatrix} 1 \\ \omega \\ \omega^2 \end{bmatrix}$ (c) $(\omega - \omega^2)\begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$ (d) None of these

Q 31. If A = $\begin{bmatrix} \frac{-1+\sqrt{3}i}{2i} & \frac{-1-\sqrt{3}i}{2i} \\ \frac{1+\sqrt{3}i}{2i} & \frac{1-\sqrt{3}i}{2i} \end{bmatrix}$ and f(x) = $x^2 + 2$, then f(A) equals :

(a) $\frac{5-\sqrt{3}i}{2}\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (b) $\frac{7+\sqrt{3}i}{2}\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (c) $\frac{3-\sqrt{3}i}{2}\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

Q 32. The trace of the matrix $\begin{bmatrix} 2 & 0 & 3 \\ 7 & -2 & 3 \\ 1 & 1 & 5 \end{bmatrix}$ is :

(a) 9 (b) 5 (c) 1 (d) – 4

Q 33. The cofactor of 6 in the determinant of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$ is :

(a) 3 (b) – 3 (c) 6 (d) – 6

Q 34. If A = $\begin{bmatrix} 3-2i & 3+5i \\ 2 & 3-2i \end{bmatrix}$, then adjA is :

(a) $\begin{bmatrix} 3-2i & 2 \\ 3+5i & 3-2i \end{bmatrix}$ (b) $\begin{bmatrix} 3-2i & -2 \\ -3-5i & 3-2i \end{bmatrix}$ (c) $\begin{bmatrix} 3-2i & -3-5i \\ -2 & 3-2i \end{bmatrix}$ (d) $\begin{bmatrix} 3-2i & 3+5i \\ -2 & -3+2i \end{bmatrix}$

Q 35. If A = $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$, (ad ≠ bc) then A^{-1} equals :

(a) $\frac{1}{ad-bc}\begin{bmatrix} d & -c \\ -b & a \end{bmatrix}$ (b) $\frac{1}{ad-bc}\begin{bmatrix} d & d \\ c & a \end{bmatrix}$ (c) $\frac{1}{bc-ad}\begin{bmatrix} -d & b \\ c & -a \end{bmatrix}$ (d) None of these

Q 36. Which of the following is not correct :
(a) (AB)' = A'B' (b) (AB)' = B'A' (c) (A + B)' = A' + B' (d) (λA)' = λA'.

Q 37. Which of the following is not correct :
(a) adj AB = adj B adj A (b) (AB)' = B'A' (c) $(AB)^{-1} = B^{-1}A^{-1}$ (d) all of the above

Q 38. Which of the following is correct :
(a) every symmetric matrix of odd order is singular
(b) every symmetric matrix of even order is singular
(c) every skew symmetric matrix of odd order is singular
(d) every skew symmetric matrix of even order is singular

Q 39. If A = $\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}$ satisfies the equation $A^2 - 4A - 5I_3 = 0$ then A^{-1} is :

(a) $\begin{bmatrix} -3 & 2 & 2 \\ 2 & -3 & 2 \\ 2 & 2 & -3 \end{bmatrix}$ (b) $\frac{1}{5}\begin{bmatrix} -3 & 2 & 2 \\ 2 & -3 & 2 \\ 2 & 2 & -3 \end{bmatrix}$ (c) $\begin{bmatrix} 3 & 2 & 2 \\ 2 & 3 & 2 \\ 2 & 2 & 3 \end{bmatrix}$ (d) $\frac{1}{5}\begin{bmatrix} 3 & 2 & 2 \\ 2 & 3 & 2 \\ 2 & 2 & 3 \end{bmatrix}$

Q 40. Which one of the following matrices has an inverse :

(a) $\begin{bmatrix}1&2&1\\2&3&1\\1&2&1\end{bmatrix}$ (b) $\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix}$ (c) $\begin{bmatrix}1&0&0\\0&0&0\\0&0&0\end{bmatrix}$ (d) $\begin{bmatrix}1&0&0\\1&0&0\\1&0&1\end{bmatrix}$

Q 41. The value of the determinant of the inverse of the matrix $\begin{bmatrix}-4&-5\\2&2\end{bmatrix}$ is :

(a) $\frac{1}{2}$ (b) 2 (c) 3 (d) 1

Q 42. Fill the numbers in the place of * $\begin{bmatrix}*&*\\*&*\end{bmatrix}\begin{bmatrix}5&6\\4&5\end{bmatrix}=\begin{bmatrix}1&0\\0&1\end{bmatrix}$

(a) $\begin{bmatrix}3&4\\0&2\end{bmatrix}$ (b) $\begin{bmatrix}5&6\\4&5\end{bmatrix}$ (c) $\begin{bmatrix}2&4\\4&3\end{bmatrix}$ (d) $\begin{bmatrix}5&-6\\-4&5\end{bmatrix}$

Q 43. If $A=\begin{bmatrix}0&-\tan\frac{\alpha}{2}\\\tan\frac{\alpha}{2}&0\end{bmatrix}$ and $I_1=\begin{bmatrix}1&0\\0&1\end{bmatrix}$ then $I_2 + A = (I_2 - A)\,M$, where M is given by :

(a) $\begin{bmatrix}\cos\alpha&\sin\alpha\\-\sin\alpha&\cos\alpha\end{bmatrix}$ (b) $\begin{bmatrix}\cos\alpha&-\sin\alpha\\\sin\alpha&\cos\alpha\end{bmatrix}$ (c) $\begin{bmatrix}\sin\alpha&-\cos\alpha\\\cos\alpha&\sin\alpha\end{bmatrix}$ (d) None of these

Q 44. If $A\begin{bmatrix}2&3\\4&5\end{bmatrix}=\begin{bmatrix}0&-4\\10&3\end{bmatrix}$ then A equals :

(a) $\begin{bmatrix}\frac{-11}{2}&4\\-19&12\end{bmatrix}$ (b) $\begin{bmatrix}\frac{-11}{2}&\frac{11}{2}\\-19&-12\end{bmatrix}$ (c) $\begin{bmatrix}-8&4\\-19&12\end{bmatrix}$ (d) $\begin{bmatrix}-16&8\\-38&24\end{bmatrix}$

Q 45. If $A=\begin{bmatrix}1&1\\0&1\end{bmatrix}$ then $(A^n)^{-1}$ equals :

(a) $\begin{bmatrix}1&-n\\0&1\end{bmatrix}$ (b) $\begin{bmatrix}1&0\\-n&1\end{bmatrix}$ (c) $\begin{bmatrix}1&0\\n&1\end{bmatrix}$ (d) $\dfrac{\begin{bmatrix}1&0\\-n&1\end{bmatrix}}{1-n}$

Q 46. Square root of $\begin{bmatrix}1&0\\0&1\end{bmatrix}$ is $\begin{bmatrix}a&b\\c&-a\end{bmatrix}$ when :

(a) $1 - a^2 = bc$ (b) $1 - a^2 = -bc$ (c) $1 - b^2 = ac$ (d) $1 + b^2 = ac$

Q 47. If inverse of the matrix $\begin{bmatrix}a_1&b_1&c_1\\a_2&b_2&c_2\\a_3&b_3&c_3\end{bmatrix}$ is $\frac{1}{67}\begin{bmatrix}-6&17&13\\14&5&-8\\-15&9&-1\end{bmatrix}$ then solution of system of linear equations $a_1x + b_1y + c_1z = -4$; $a_2x + b_2y + c_2z = 2$ and $a_3x + b_3y + c_3z = 11$ is :

(a) $x = 3, y = -2, z = 1$ (b) $x = 1, y = 2, z = 3$ (c) $x = 1, y = 2, z = -3$ (d) cannot determine from given data

Q 48. Let $[A]=\begin{bmatrix}-1 & 0\\ 0 & 1\end{bmatrix}$, $[B]=\begin{bmatrix}0 & 1\\ 1 & 0\end{bmatrix}$ & $[C]=\begin{bmatrix}-\sin\theta & \cos\theta\\ \cos\theta & \sin\theta\end{bmatrix}$ then C is :

(a) [A] sin θ + [B] cos θ (b) [A] sinθ – [B] cosθ (c) –[A] sin θ + [B] cosθ
(d) – [A] sin θ – [B] cosθ

Q 49. Inverse of the matrix $\begin{bmatrix}\cos\alpha & -\sin\alpha\\ \sin\alpha & \cos\alpha\end{bmatrix}$ is :

(a) $\begin{bmatrix}\cos\alpha & \sin\alpha\\ -\sin\alpha & \cos\alpha\end{bmatrix}$ (b) $\begin{bmatrix}\cos\alpha & \sin\alpha\\ \sin\alpha & \cos\alpha\end{bmatrix}$ (c) $\begin{bmatrix}\cos\alpha & \cos\alpha\\ \sin\alpha & \sin\alpha\end{bmatrix}$ (d) $\begin{bmatrix}-\cos\alpha & -\sin\alpha\\ \sin\alpha & \cos\alpha\end{bmatrix}$

Q 50. Inverse of the matrix $A=\begin{bmatrix}1 & 3 & 3\\ 1 & 4 & 3\\ 1 & 3 & 4\end{bmatrix}$ equals :

(a) Adj A (b) 2 Adj A (c) A (d) A^T

Q 51. Rank of the matrix $\begin{bmatrix}3 & -3 & 0\\ 1 & 4 & 5\\ 4 & 4 & 5\end{bmatrix}$ is :

(a) 0 (b) 1 (c) 2 (d) 3

Q 52. Rank of the matrix $\begin{bmatrix}1 & -3 & 2\\ -3 & 9 & -6\\ 2 & -6 & 4\end{bmatrix}$ is :

(a) 0 (b) 1 (c) 2 (d) 3

In the following (54 to 61) one or more than one alternative may be correct :

Q 53. If |A| denotes the determinant of matrix $A=\begin{bmatrix}1 & 1 & 1\\ -1 & 1 & 1\\ -1 & -1 & 1\end{bmatrix}$ then |5A| equals :

(a) 4 (b) 0 (c) 20 (d) 500

Q 54. $\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}$ is :

(a) a unit matrix (b) identify matrix (c) a diagonal matrix (d) a scalar matrix

Q 55. A matrix $A = [a_{ij}]_{m \times n}$ is :
(a) a horizontal matrix if m > n (b) a horizontal matrix if m < n
(c) a vertical matrix if m > n (d) a vertical matrix if m < n

Q 56. Choose the correct statement (s) about multiplication of two matrices A and B
(a) when ever AB exists, it is not always necessary that BA also exist
(b) when ever AB and BA both exist it is always not necessary that they should be matrices of the same type (order)
(c) when AB and BA both exist and are of the same order, then AB = BA
(d) AB is never equal to BA

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Q 57. Which of the following is correct :
(a) If A is a square matrix (A + A') is a symmetric matrix
(b) If A is a square matrix (A – A') is a skew symmetric matrix
(c) Every square matrix can be expressed as the sum of symmetric and a skew symmetric matrix
(d) Some elements of the skew symmetric matrix must be zero

Q 58. If $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 3 & 1 \end{bmatrix}$, $B = \begin{bmatrix} -4 & -4 \\ -1 & 3 \end{bmatrix}$, C = [3 2 1], then which of the following exist :
(a) AB (b) BA (c) AC (d) CA

Q 59. If $A = \begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$ then
(a) $A^{-1} = \text{Adj } A$ (b) Adj A has four "zero" elements
(c) A^{-1} doesnot exist if $\alpha = n\pi$ (d) $\text{Adj } A = A^T$

Q 60. If A and B are inveriable square matrices of the same order then which of the following is correct :
(a) *adj* (AB) = (adj A) (adj B) (b) (adj A)' = (adj A')
(c) $|\text{adj } A| = |A|^{n-1}$ (d) $\text{adj }(\text{adj } B) = |B|^{n-2} B$

Q 61. If $A = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$, B = [4 5 6], $C = \begin{bmatrix} 0 \\ -2 \\ 4 \end{bmatrix}$ then

(a) $AB = \begin{bmatrix} 4 & 5 & 6 \\ 8 & 10 & 12 \\ 12 & 15 & 18 \end{bmatrix}$ (b) AB = [32] (c) $(ABC)^T = [14 \quad 28 \quad 42]$ (d) ABC is not defined

ANSWERS

1 c	2 b,c,d	3 a	4 d	5 a	6 b	7 a	8 c	9 d	10 c
11 a	12 d	13 b	14 c	15 d	16 b	17 b	18 d	19 d	20 c
21 a	22 a	23 d	24 c	25 b	26 d	27 c	28 d	29 c	30 d
31 b	32 b	33 c	34 c	35 c	36 a	37 d	38 c	39 b	40 b
41 a	42 d	43 b	44 c	45 a	46 a	47 a	48 a	49 a	50 a
51 d	52 b	53 d	54 a,b,c,d	55 b,c	56 a,b	57 a,b,c,d	58 b	59 a,b	60 b,c,d
61 a,c									

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