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Transpose of a matrix :

If $A = [a_{ij}]_{m\times n}$ then transpose of A is denoted by A^T is defined as
$A^T = [b_{ij}]n \times m$.

$$2A = \begin{bmatrix} 2a & 2b & 2c \\ 2d & 2e & 2f \end{bmatrix}_{2\times 3}$$

Example : Let $A = \begin{bmatrix} 1 & 2 & 3 \\ 1 & 3 & 1 \end{bmatrix}$ then $A^T = \begin{bmatrix} 1 & 1 \\ 2 & 3 \\ 3 & 1 \end{bmatrix}$.

$$2A^T = 2\begin{bmatrix} a & d \\ b & e \\ c & f \end{bmatrix}_{3\times 2}$$

Properties of transpose of matrix :

$$2A^T = 2A$$

If A & B are two matrices and k is any number then

$$(2A)^T = 2A$$

(1) $(kA)^T = kA^T$

(2) $(A + B)^T = A^T + B^T$

(3) $(AB)^T = B^T A^T$

(4) If A is square matrix then $(A^n)^T = (A^T)^n$.

$(A)^T = (A^T)^n$

Conjugate of a matrix :

$z = x + iy$

$\bar{z} = x - iy$

If $A = [a_{ij}]_{m\times n}$ then conjugate of A denoted by $\overline{A}$.

Conjugate transpose of a matrix :

$(\bar{A})^T = A^\theta$

If $A = [a_{ij}]_{m\times n}$ then conjugate transpose of A denoted by A^θ as $A^\theta = (\overline{A})^T$.

(2) $(A + B)^\theta = A^\theta + B^\theta$

(3) $(AB)^\theta = B^\theta A^\theta$

Trace of a square matrix : Sum of all diagonal elements of a square matrix A is known as Trace of A.

$$A = \begin{bmatrix} 1 & 7 & 5 \\ 3 & 2 & 5 \\ 10 & 5 & 6 \end{bmatrix}$$

$$Tr\,A = 1 + 2 + 6 = 9$$

Q.1 Let $A = \begin{bmatrix} a & 0 & 1 \\ 0 & 1 & 2 \\ 1 & 2 & 3 \end{bmatrix}$ be a matrix of order 3 whose Trace is 5, then value of a is

(a) 0 (b) 1

(c) 2 (d) -1

$Tr\, A = 5$

$a + 1 + 3 = 5$

$a + 4 = 5$

$a = 5 - 4 = 1$

Properties of Trace of matrix (A) :

(1) If A be a square matrix of order n and k is any number then $Tr(kA) = kTr(A)$

(2) If A & B are square matrix of same order n, then $Tr(A + B) = Tr(A) + Tr(B)$

(3) $Tr(AB) = Tr(BA)$

(4) If $A = [a_{ij}]_{m\times n}$ is any matrix then Trace (AA^T) = Sum of squares of every element of A.

(5) $Tr(AA^{\theta})$ = sum of the squares of modulus of each element of A.

$|1+i|^2$

$1 + 2i + i^2$

$|2i| = 2$

Q2. A real n ×n matrix A = [a_{ij}] is defined as

$$\begin{cases} a_{ij} = i & \forall\ i = j \\ 0 & Otherwise \end{cases}, \text{ then Trace(A) is}$$

(a) $\dfrac{n(n+1)}{2}$ (b) $\dfrac{n(n-1)}{2}$

(c) $\dfrac{n(n+1)(2n+1)}{2}$ (d) n^2

$a_{ii} = i$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & \cdots & 0 \\ 0 & 2 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 3 & 0 & 0 & \cdots \\ \vdots & & & & \ddots & \\ 0 & \cdots & & \cdots & & n \end{bmatrix}$$

a_{23}

$a_{11} = 1$

$a_{22} = 2$

$a_{33} = 3$

$a_{44} = 4$

$1 + 2 + 3 + \cdots n$

$\dfrac{n(n+1)}{2}$

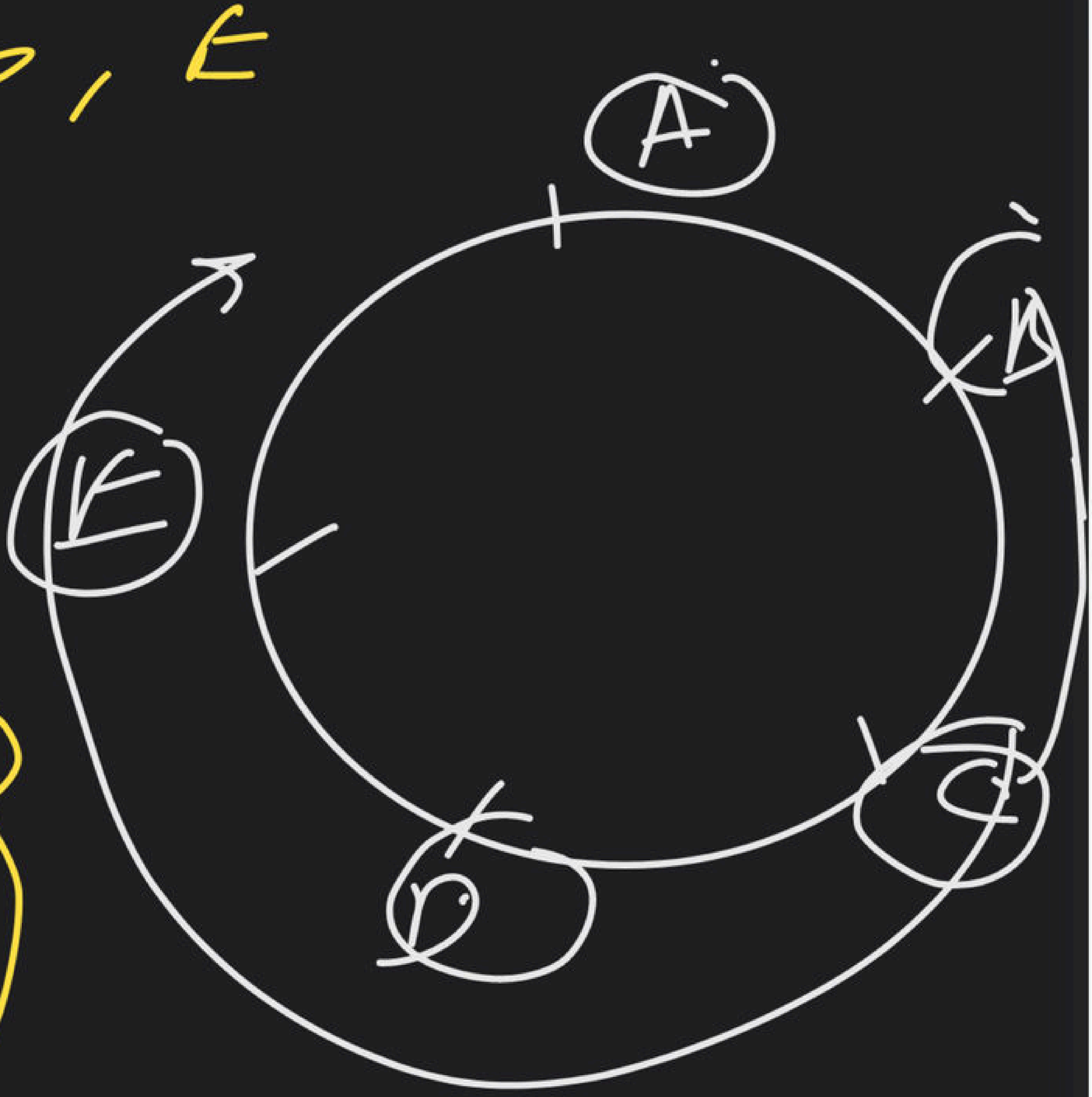
A, B, C, D, E

~~Tv(BCDEA)~~

Tv(BCADE)

~~Tv(CDEAB)~~

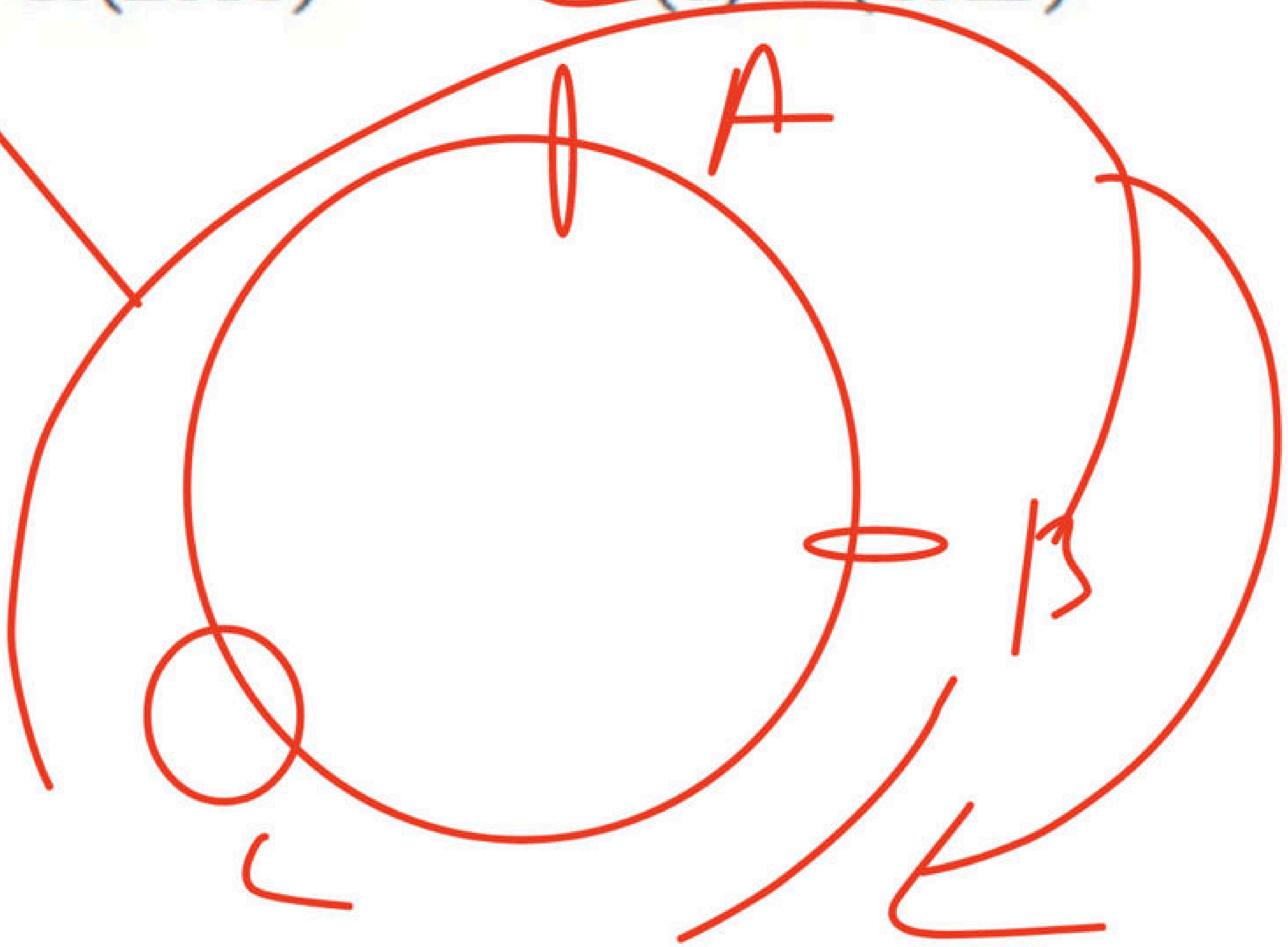
Tv(DCBA)



Q.3 If A, B & C are square matrix of same order then which of the following is/are equal to Tr(ABC) is

(a) Tr(ACB) ~~(b) Tr(BCA)~~

(c) Tr(BAC) ~~(d) Tr(CAB)~~



a	a	c
b	b	d
c	c	b
d	d	a

Q.4. If $S = \left\{ A = [a_{ij}]_{3\times 3} \mid AA^T = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix} \& a_{ij} \in R \right\}$. Then is

(a) Empty set (b) Singleton set

(c) Countably infinite set (d) Uncountable set

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$Tr(AA^T) = 0$$

$$A = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

$$AA^T = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

$$A = \begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}$$

$$Tr(AA^T) = a^2+b^2+c^2+d^2+e^2+f^2+g^2+h^2+i^2$$

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Definition of Determinant : Let $A = [a_{ij}]_{n\times n}$ be a matrix, then $|A|$ is called a determinant of order n.

(1) Determinant of order 2 :

Let $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$

$|A| = a_{11}.a_{22} - a_{21}.a_{12}$

$A = \begin{pmatrix} 5 & 7 \\ 2 & 3 \end{pmatrix}$

$|A| = 15 - 14 = 1$

(2) Determinant of order 3 :

Let $A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$

Then $|A| = a_{11}\begin{vmatrix} a_{22} & a_{23} \\ a_{32} & a_{33} \end{vmatrix} - a_{12}\begin{vmatrix} a_{21} & a_{23} \\ a_{31} & a_{33} \end{vmatrix} + a_{13}\begin{vmatrix} a_{21} & a_{22} \\ a_{31} & a_{32} \end{vmatrix}$

Singular matrix : If $|A| = 0$ then this matrix is called Singular matrix

Non – Singular matrix : If $|A| \neq 0$,then this matrix is called non – singular matrix

$$\begin{array}{c} 3 \\ \\ 1 \end{array}\begin{bmatrix} 1 & 2 & 2 \\ 0 & 0 & 1 \\ 2 & 3 & 1 \end{bmatrix}\begin{array}{c} 1 \\ \\ 2 \end{array}$$

$$(0+0+4) - (0+0+3)$$

$$4-3=1$$

$$\begin{array}{c} 7 \\ \\ 6 \end{array} \begin{bmatrix} 1 & 4 & 7 \\ 2 & 3 & 1 \\ 5 & -1 & 6 \end{bmatrix} \begin{array}{c} 1 \\ 5 \\ \\ \end{array}$$

$$(-14+18+20) - (48+105-1)$$

$$24 - 48 - 105 + 1$$

$$\underline{-128}$$

Q .5. The number of distinct real values of x for which the matrix $\begin{pmatrix} x & 1 & 1 \\ 1 & x & 1 \\ 1 & 1 & x \end{pmatrix}$ is singular is

(a) 1 (b) ~~2~~

(c) 3 (d) infinite

$(1+x^3+1) - (x+x+x) = 0$

$x^3+2-3x=0$

$x^3-3x+2=0$

$1, 1, -2$

$1, 1, -2$

Property of determinant :

(1) Determinant of diagonal matrix is product of all diagonal element

(2) Determinant of Identity matrix is always one

(3) Determinant of upper or lower triangular matrix is always product of diagonal elements

$$\begin{bmatrix} 1 & 100 & 1000 \\ 0 & 2 & 1000 \\ 0 & 0 & 3 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 5 & 0 \\ 0 & 7 & 0 \\ 0 & 0 & 9 \end{bmatrix}$$

(4) The value of determinant doesnot change when rows and columns are interchanged

(5) If any two rows or columns are identically then value of determinant is zero

$\det A = \det A^T$

$$\begin{pmatrix} 1 & 2 & 7 & 8 \\ 1 & 5 & 7 & 8 \\ 2 & 3 & 3 & 6 \\ 5 & 7 & 9 & 2 \end{pmatrix} \qquad \begin{pmatrix} 1 & 2 & 5 \\ 3 & 7 & 4 \\ 4 & 9 & 9 \end{pmatrix}$$

(6) $|A^T| = |A|$

(7) $|A+B|$ and $|A| + |B|$ may not be equal

(8) Let $A = [a_{ij}]_{n\times n}$ & then $|kA| = k^n|A|$

(9) Let A & B are two matrix then $|AB| = |A|.|B|$

$\det(A_{4\times4}) = 10$

$\det(2A) = 2^4 \times 10$

$= 16 \times 10$

$= 160$

Q.6. Let P be 4×4 matrix whose determinant is 10. The determinant of the matrix -3P is

(a) -810 (b) -30

(c) 30 (d) 810

$\det P = 10$

$\det(-3P) = (-3)^4\, 10$

$= 81 \times 10$

Q7. Let $A = \begin{bmatrix} 2 & 3 & 1 \\ 5 & 1 & 2 \\ 1 & 0 & 0 \end{bmatrix}$ then

(a) A is invertible

(b) |A| is odd

(c) |A| is divisible by 2

(d) |A| is prime number

$(0+0+5)-(0+1+0)$

$5-1=4$

Q.8. It is known that $X = X_0 \in M_2(Z)$ is a solution of $AX - XA = A$ for some $A \in \left\{ \begin{pmatrix} 1 & 1 \\ -1 & -1 \end{pmatrix}, \begin{pmatrix} -1 & 1 \\ 1 & -1 \end{pmatrix}, \begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix} \right\}$. Which of the following values are not possible for the determinant of X_0?

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(a) $\det(X_0) = 0$ (b) $\det(X_0) = 2$

(c) $\det(X_0) = 6$ (d) $\det(X_0) = 10$

Q.9. Let M & N be any two 4×4 matrices with integer entries.

Satisfying $MN = 2\begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$. Then the maximum value of det(M) + det(N) is

(a) 16 (b) 17

(c) 18 (d) 19

$\det(MN) = 16$

$\det M \det N = 1 \times 16$

2×8

4×4

17

10

8

$A_{n\times n} = (a_{ij}),\ \underline{n \geq 3}$

$a_{ij} = (b_i^2 - b_j^2)$

$\det(A)$

3×3

(a) $\prod(b_i - b_j)$

(b) $\prod(b_i + b_j)$

(c) 0

(d)

$$|A| = \begin{bmatrix} 0 & b_1^2 - b_2^2 & b_1^2 - b_3^2 \\ b_2^2 - b_1^2 & 0 & b_2^2 - b_3^2 \\ b_3^2 - b_1^2 & b_3^2 - b_2^2 & 0 \end{bmatrix}$$

$$|A| = 0$$

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}$$


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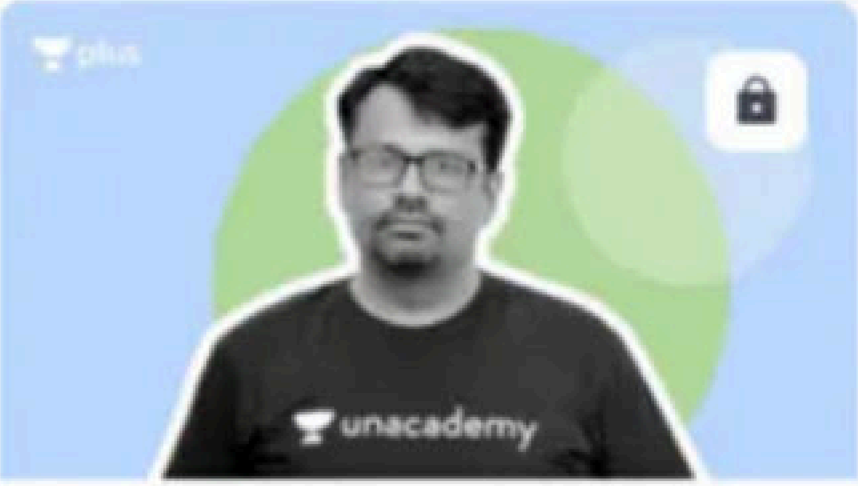

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- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
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