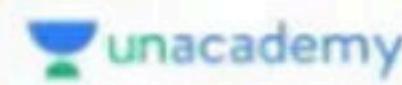


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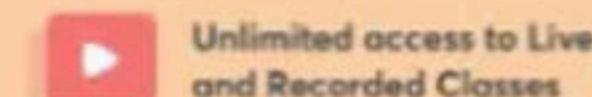
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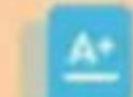
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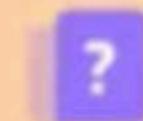
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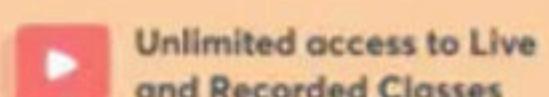
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Diagonal Matrix : Let $A = (a_{ij})_{n \times n}$ then A is diagonal matrix if

$a_{ij} = 0$ for all $i > j, i < j$ or $a_{ij} = 0$ for all $i \neq j$.

Scalar Matrix : A diagonal matrix A is said to be scalar matrix

if $a_{ij} = \begin{cases} 0 & i \neq j \\ k & i = j \end{cases}$



Note :

1. Number of non-trivial entries of diagonal matrix of order n .
= n (number of diagonal entries)
2. If D be a diagonal matrix then $AD = DA$ for all $A \in M_{n \times n}$
Iff D is a scalar matrix.

Symmetric matrix : A square matrix A is said to be symmetric if $A = A^T$ i.e. $a_{ij} = a_{ji}$; for all i, j .

Properties :

- (1) If A be any square real matrix then $A + A^T$ is always symmetric.

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

- (2) If A is any square matrix then AAT is always symmetric.

$$(AA^T)^T = (A^T)^TA^T = AA^T$$

- (3) If A is symmetric matrix then P^TAP is always symmetric.

When P is any square matrix of order same as A .

$$(P^TAP)^T = P^T A^T (P^T)^T = P^T A^T P$$

Given that $A^T = A$

$$\text{So, } (P^TAP)^T = P^TAP$$

- (4) If A is symmetric matrix then kA is also symmetric matrix for all $k \in \mathbb{R}$

$$(kA)^T = k^T A^T = kA$$

(5) If A & B are symmetric then

- (i) A + B is symmetric
- (ii) AB is symmetric if $AB = BA$
- (iii) $\alpha A + \beta B$ is symmetric for all $\alpha, \beta \in R$
- (iv) Ak is symmetric ; for all $k \in R$
- (v) AB + BA is symmetric.

$$(AB + BA)^T = (AB)^T + (BA)^T$$

$$= B^T A^T + A^T B^T$$

$$= BA + AB = AB + BA$$

Skew Symmetric Matrix : A square matrix is said to be skew symmetric matrix if $A^T = -A$

i.e. $a_{ij} = -a_{ij}$ for all i, j

for $i = j$ (for diagonal elements)

$$a_{ii} = -a_{ii}$$

$$\Rightarrow 2a_{ii} = 0 \Rightarrow a_{ii}$$

\Rightarrow All diagonal entries of a skew-symmetric matrix are zero.

Note : Odd order skew-symmetric matrix are always singular i.e.

$$|A| = 0$$



Q.1 Let $S = \{A \in M_{n \times n}; A = A^T \text{ & } A^T = -A\}$, then cardinality of S is

- (a) 1
 - (b) ϕ
 - (c) infinite
 - (d) 2022

Property :

- (1) A be a square matrix then $A - A^T$ is skew symmetric matrix.

$$(A - A^T)^T = A^T - A = -(A - A^T)$$

- (2) If A is skew symmetric matrix then P^TAP is also skew symmetric matrix where P be any square matrix of order same is A.

(3) A & B are skew-symmetric matrix then

- (i) A + B is skew-symmetric matrix.
- (ii) AB is skew-symmetric if $AB = BA$
- (iii) kA is skew-symmetric.
- (iv) $\alpha A + \beta B$ is skew-symmetric.

→ k is odd then skew-symmetric.

- (v) A^k
 - k is odd then skew-symmetric.
 - k is even then symmetric.

$$(A^k)^T = (A^T)^k = (-A)^k = (-1)^k A^k$$

$$= \begin{cases} -A^k & \text{if } k \text{ is odd} \\ A^k & \text{if } k \text{ is even} \end{cases}$$

Q.2. Let A is skew-symmetric matrix then

- (a) A^{2020} is symmetric matrix.
- (b) A^{2021} is symmetric matrix
- (c) A^{2022} is skew symmetric matrix
- (d) A^{2021} is skew symmetric matrix

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(3) **Hermitian matrix** : A square complex matrix A is Hermitian if $A^\theta = A$

i.e. $a_{ij} = \overline{a_{ji}}$; for all i, j

For $i = j$ (for diagonal elements)

$$a_{ii} = \overline{a_{ii}}$$

$\Rightarrow a_{ii}$ is real.

\Rightarrow All diagonal entries of Hermitian matrix are purely real.

Note : Number of non-trivial entries in Hermitian matrix.

$$A = \begin{bmatrix} a & \alpha + i\beta \\ \alpha - i\beta & b \end{bmatrix}$$

Property : If A is Hermitian matrix then kA

- (a) If $k \in \mathbb{R}$, then $(kA)^\theta = kA^\theta = kA$

\Rightarrow kA is Hermitian matrix.

- (b) If $k \in \mathbb{C}$

- (i) k is purely imaginary, then $(kA)^\theta = k^\theta A^\theta = -kA$

\Rightarrow kA is skew-Hermitian matrix.

- (ii) $k = \alpha + i\beta$, then $[(\alpha + i\beta)A]^\theta$

$$= (\alpha - i\beta)A \neq (\alpha + i\beta)A$$

Then kA is not Hermitian matrix.

- (c) A & B are Hermitian matrix then A + B is also Hermitian matrix and AB is Hermitian if $AB = BA$

- (d) If A is Hermitian matrix, then A^n is Hermitian matrix.

$$(A^n)^\theta = (A^\theta)^n = A^n$$

Skew-Hermitian matrix : If $A^\theta = -A$ then A is skew-Hermitian

matrix i.e. $a_{ij} = \overline{-a_{ji}}$.

For $i = j$ (for diagonal element)

$$a_{ii} = \overline{-a_{ii}}$$

$\Rightarrow a_{ii}$ is either zero or purely imaginary.

Property : If A is skew-Hermitian matrix then kA is

(i) If $k \in \mathbb{R}$ then $(kA)^\theta = kA^\theta = -kA$

kA is skew-symmetric matrix.

(ii) If k is purely imaginary.

Q.3. Suppose A is a real square matrix of odd order such that $A + A^T = 0$. Then which of the following is true?

- (a) A is singular matrix
- (b) A is non-singular matrix
- (c) A is symmetric matrix
- (d) A is skew-symmetric matrix

Q.6. The diagonal elements of Hermitian matrix are –

- (a) Complex number
- (b) Real numbers
- (c) Natural numbers
- (d) None of these

▲ 1 • Asked by Millan

Happy teacher's day, sir. Appke liye aye chota sa gift he.
Appke photo meri first face drawing he . Plz sir and class
mates bhura math mana, drawing achi nehi he to.



Q.7. The diagonal elements of Skew-Hermitian matrix are –

- (a) Pure real numbers or zero
- (b) Pure imaginary or zero
- (c) Complex number
- (d) None of these

Q.1 It is known that $X = X_0 \in M_2(\mathbb{Z})$ 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) $\det(X_0) = 10$

Let $A = \begin{bmatrix} a & 0 & \dots & b \\ 0 & a & \dots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ b & 0 & 0 & a \end{bmatrix}_{n \times n}$ then $|A| = (a^2 - b^2)^{\left[\frac{n}{2}\right]}$.

Q2. The determinant of the matrix $\begin{vmatrix} 0 & 0 & 1 & 2 & 0 & 0 \\ 0 & 0 & 2 & 1 & 0 & 0 \end{vmatrix}$ is

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 2 \\ 0 & 1 & 0 & 0 & 2 & 0 \\ 0 & 0 & 1 & 2 & 0 & 0 \\ 0 & 0 & 2 & 1 & 0 & 0 \\ 0 & 2 & 0 & 0 & 1 & 0 \\ 2 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} i$$

Q.4.

Let $D_1 = \det \begin{bmatrix} a & b & c \\ x & y & z \\ p & q & r \end{bmatrix}$, $D_2 = \det \begin{bmatrix} -x & a & -p \\ y & -b & q \\ z & -c & r \end{bmatrix}$. Then

(a) $D_1 = D_2$

(b) $D_1 = 2D_2$

(c) $D_1 = -D_2$

(d) $2D_1 = D_2$



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- 📍 Studied at M.Sc., NET, PhD(Algebra), MBA(Finance), BEd
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