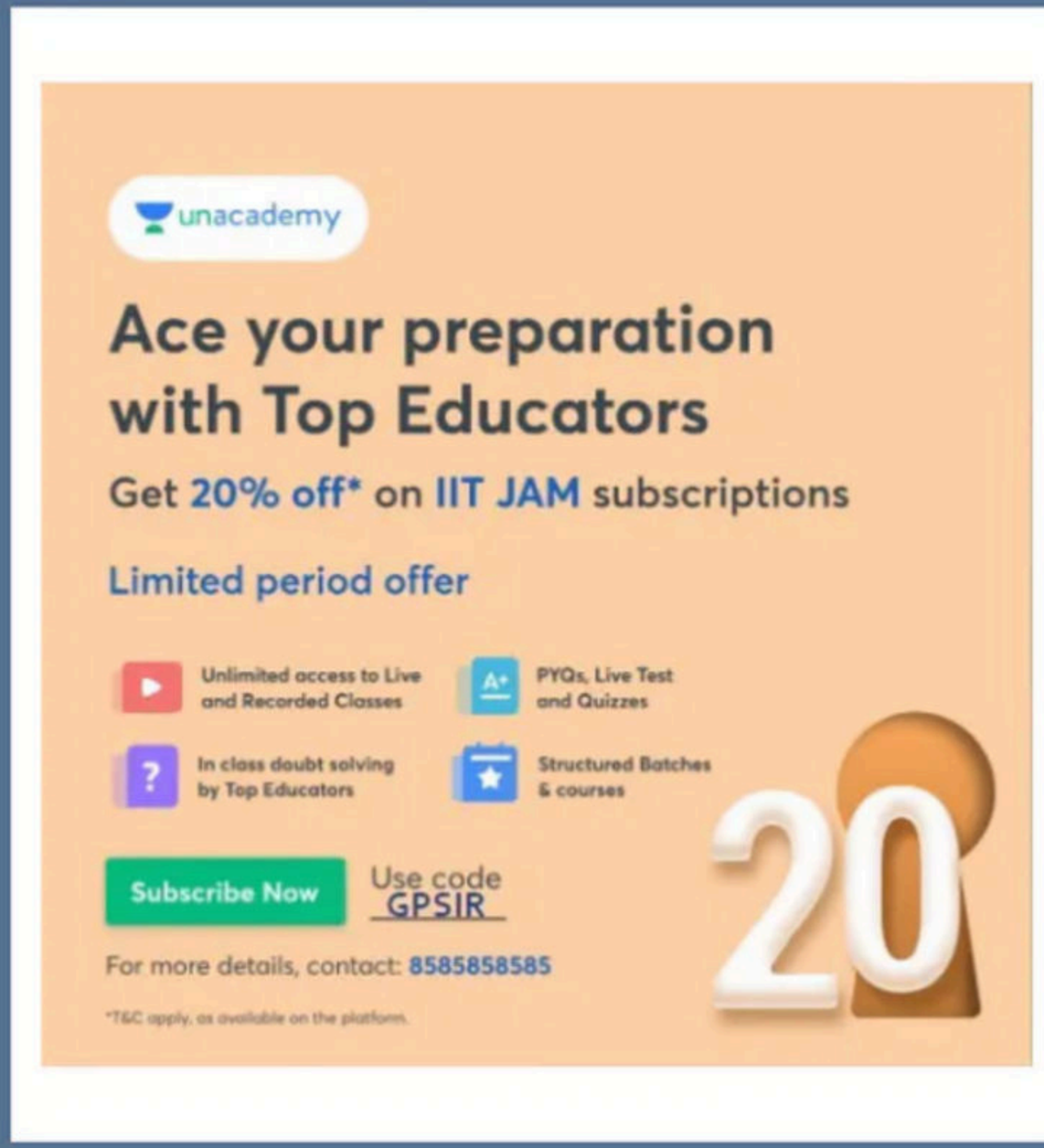
Vector Space - Part I

Detailed Course 2.0 on Linear Algebra For IIT JAM' 23

Gajendra Purohit • Lesson 1 • Sept 8, 2022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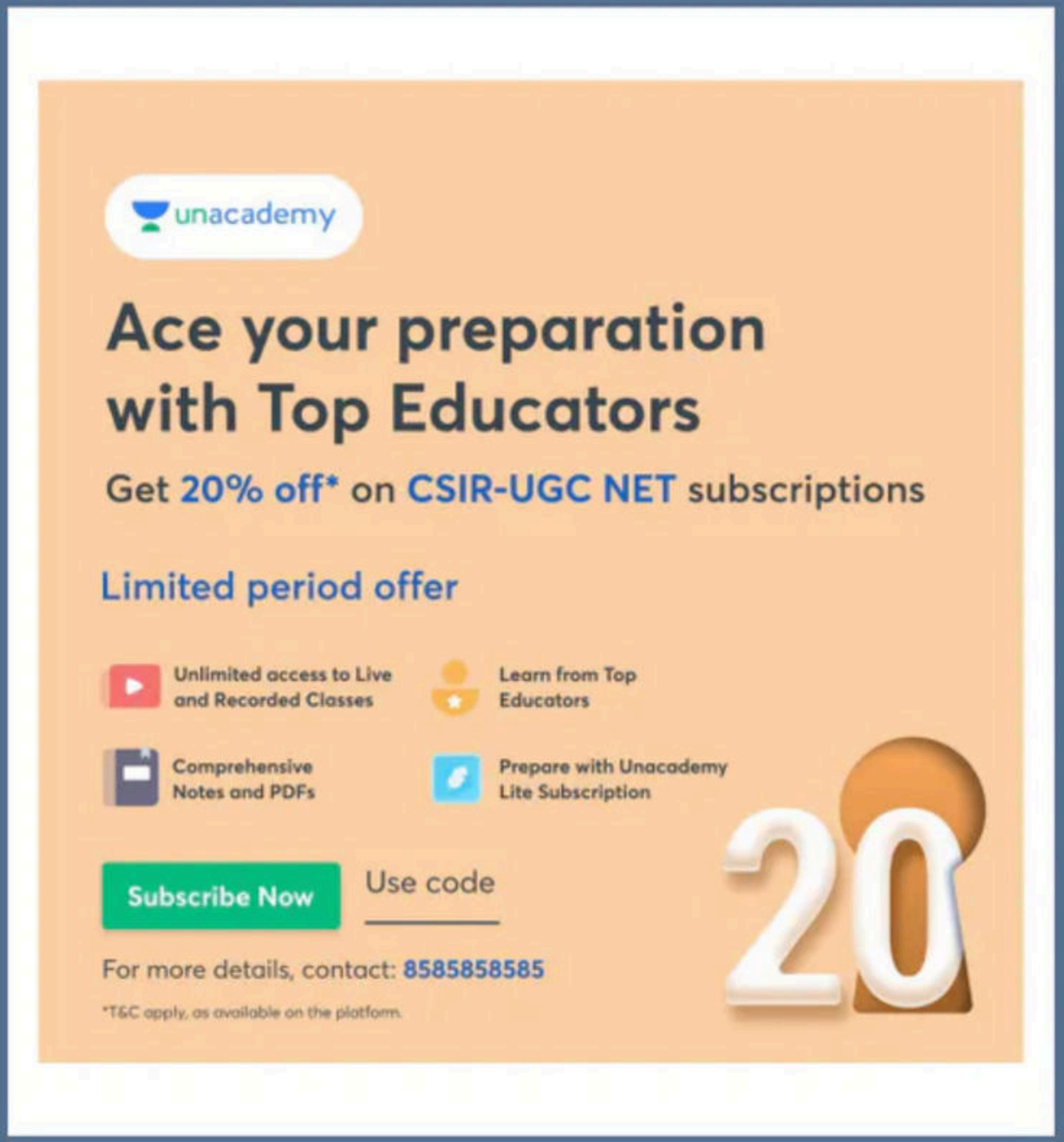
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Matrix and their properties

Definition : A set of mn numbers arranged in the form of rectangular array consisting of m-rows and n-columns is called an m × n matrix or matrix of order m × n and denoted by $A = [a_{ij}]_{m\times n}$.

Matrix over any field : $A = [a_{ij}]_{m\times n}$ is matrix over any field F if $a_{ij} \in F$, for all i,j and matrix A is known as F – matrix.

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Algebra of matrix :

1. **Equality of two matrix :** If $A = [a_{ij}]_{m\times n}$ & $B = [b_{ij}]_{m\times n}$ are said to be equal matrix if $a_{ij} = b_{ij}$; for all i,j

2. **Multiplication of two matrices :** Two matrices A & B are conformable for multiplication if number of columns in A is equal to number of rows in B i.e. AB exist if $A = [a_{ij}]_{m\times n}$ & $B = [b_{ij}]_{n\times p}$. Then $AB = C = [C_{ij}]_{m\times p}$.

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Q.1: Let $A=\begin{bmatrix}0 & 1\\ 0 & 2\\ 1 & 0\end{bmatrix}$ & $B=\begin{bmatrix}1 & 2 & 3\end{bmatrix}$, then which of the following is true?

(a) AB exist (b) BA exist

(c) Given data is insufficient

(d) None of these

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Q.2. Let $A_i = \begin{bmatrix} \cos^2\theta_i & \cos\theta_i \sin\theta_i \\ \cos\theta_i \sin\theta_i & \sin^2\theta_i \end{bmatrix}$, i = 1, 2. Then

$A_1A_2 = 0$ if

(a) $\theta_1 = \theta_2 + (2k + 1)\pi/2$, k = 0, 1, 2....

(b) $\theta_1 = \theta_2 + k\pi$,, k = 0, 1, 2 ....

(c) $\theta_1 = \theta_2 + 2k\pi$, k = 0, 1, 2, ...

(d) $\theta_1 = \theta_2 + k\pi/2$, k = 0, 1, 2, ...

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Q.3 How many elements do the set $S=\left\{A=\begin{bmatrix}2 & 3x\\ \frac{3}{x} & 2\end{bmatrix}: x \in R \setminus \{0\}\right\}$ Have, such that each element of the set satisfies the equation $A^2 - 4A - 5I = 0$

(a) Infinitely many (b) 1

(c) 2 (d) 3

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3. Positive integral power of a square matrix :

If $A = [a_{ij}]_{m\times n}$ then $A^2 = A.A$ &$A^k = A.A. \ldots\ldots A$ (k-times)

Note :

(1) If sum of element in each row or each column of a square matrix A is 'a' then sum of element in each row or each column of a square matrix A^n is a^n.

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Note :

(2) If each row or column sum in A is a & each row or column sum in B is b then each row or column sum in AB is ab.

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Q.5 If $A=\begin{bmatrix}3 & -2\\ 2 & -1\end{bmatrix}$, then A^{20} equals

(a) $\begin{bmatrix}41 & 40\\ -40 & -39\end{bmatrix}$ (b) $\begin{bmatrix}41 & -40\\ 40 & -39\end{bmatrix}$

(c) $\begin{bmatrix}41 & -40\\ -40 & -39\end{bmatrix}$ (d) $\begin{bmatrix}41 & 40\\ 40 & -39\end{bmatrix}$

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Q.6. If $P=\begin{bmatrix}1 & 1 & 1\\ 0 & 1 & 1\\ 0 & 0 & 1\end{bmatrix}$, then P^{50} eqals

(a) $\begin{bmatrix}1 & 100 & 500\\ 0 & 1 & 100\\ 0 & 0 & 1\end{bmatrix}$ (b) $\begin{bmatrix}1 & 50 & 100\\ 0 & 1 & 50\\ 0 & 0 & 1\end{bmatrix}$

(c) $\begin{bmatrix}50 & 100 & 150\\ 0 & 50 & 100\\ 0 & 0 & 50\end{bmatrix}$ (d) $\begin{bmatrix}1 & 50 & 1275\\ 0 & 1 & 50\\ 0 & 0 & 1\end{bmatrix}$

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Q.7. The least positive integer n, such that $\begin{Bmatrix} \cos\pi/4 & \sin\pi/4 \\ -\sin\pi/4 & \cos\pi/4 \end{Bmatrix}^n$ is the identity matrix of order 2, is

(a) 4 (b) 8

(c) 12 (d) 16

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Q.8 If $A=\begin{bmatrix}1 & 0 & 0\\ 1 & 0 & 1\\ 0 & 1 & 0\end{bmatrix}$ then A^{50} is

(a) $\begin{bmatrix}1 & 0 & 0\\ 50 & 1 & 0\\ 50 & 0 & 1\end{bmatrix}$ (b) $\begin{bmatrix}1 & 0 & 0\\ 48 & 1 & 0\\ 48 & 0 & 1\end{bmatrix}$

(c) $\begin{bmatrix}1 & 0 & 0\\ 25 & 1 & 0\\ 25 & 0 & 1\end{bmatrix}$ (d) $\begin{bmatrix}1 & 0 & 0\\ 24 & 1 & 0\\ 24 & 0 & 1\end{bmatrix}$

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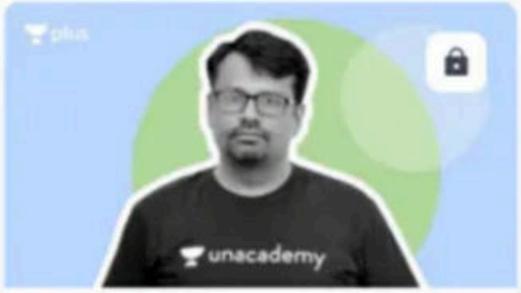

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