DS & AI
CS & IT

Linear Algebra

Lecture No. 07

By- Dr. Puneet Sharma Sir

Recap of previous lecture

Topic

Non Homogeneous System of Eq^n

Topics to be Covered

Topic

- → Homogeneous System of Eqn
- → Basics of Eigen Values.

Homogeneous system of linear Equ^n $AX=0$

eg
$$\left.\begin{aligned} 2x-y+4z&=0\\ x+2y-2z&=0\\ -x-y+3z&=0\\ x+2y-4z&=0 \end{aligned}\right\} \Rightarrow \begin{bmatrix} 2 & -1 & 4\\ 1 & 2 & -2\\ -1 & -1 & 3\\ 1 & 2 & -4 \end{bmatrix}\begin{bmatrix} x\\ y\\ z \end{bmatrix}=\begin{bmatrix} 0\\ 0\\ 0\\ 0 \end{bmatrix} \Rightarrow \boxed{A_{4\times 3}X_{3\times 1}=O_{4\times 1}}$$

By observation, we can see that $X=\begin{bmatrix} x\\ y\\ z \end{bmatrix}=\begin{bmatrix} 0\\ 0\\ 0 \end{bmatrix}$ is a solution of above system.

because these values of x, y, z satisfying all 4 equ^n at a time.

& this type of solution always exist & this sol. is known as TRIVIAL sol.

(*) Homo.g system is always consistent OR Homog system Never Inconsistent.

because Reason 1: Trivial sol always exist.

Reason 2: $\rho(A)=\rho(A:O)$ always. Hence there is No Need to write Aug Mat further.

Why zero vector is treated as LD vector →

vectors $x_1, x_2, x_3 \ldots\ldots x_r$ are called LD if $\exists$ a relationship of the type $k_1x_1 + k_2x_2 + \cdots\cdots + k_rx_r = 0$ ——— (1)

where $k_1, k_2, k_3 \ldots\ldots k_r$ should not all zero simultaneously.

eg(i) Let us consider $\begin{bmatrix}1\\-1\\0\end{bmatrix}, \begin{bmatrix}-2\\2\\0\end{bmatrix}$ and $\begin{bmatrix}0\\0\\0\end{bmatrix}$ then we have

$2x_1 + x_2 + x_3 = 0$ i.e x_1, x_2, x_3 are LD

eg(ii) Let us consider $\begin{bmatrix}1\\-1\\0\end{bmatrix}, \begin{bmatrix}2\\0\\1\end{bmatrix}$ and $\begin{bmatrix}0\\0\\0\end{bmatrix}$ then we have

$0x_1 + 0x_2 + kx_3 = 0$ i.e relationship exist where not all constants are zero Hence x_1, x_2, x_3 are LD

eg(iii) Let us consider $x = \begin{bmatrix}0\\0\\0\end{bmatrix}$ then we can write

$kx = 0$ where ~~k is non zero~~ Hence relationship again exist so x is LD

Note: ① $\underbrace{\text{underdetermined}}_{\text{unique sol = DNE}}$, $\underbrace{\text{Homog system}}_{\text{No sol = DNE}}$ always consist ___ ∞ ___ solutions

② unique sol $\simeq$ Trivial sol $\simeq$ ZERO solution (always exist)

③ ∞ solⁿ $\cong$ Non Trivial sols also exist $\cong$ Non Zero sol also exist.

④ ZERO solⁿ $\neq$ No solⁿ

$\therefore X = \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$ $\quad X = \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} ? \\ ? \\ ? \end{bmatrix}$

Methods of Solving Homog. System

$(A_{m\times n} X_{n\times 1} = O_{m\times 1})$

RANK Method

$(m>n, m=n, m<n)$

① if $\rho(A) =$ No. of Variables $\Rightarrow$ unique sol.

② if $\rho(A) <$ " " $\Rightarrow \infty$ sol.

MATRIX Method

(only for $m=n$)

① if $|A| \neq 0 \Rightarrow$ unique sol exist

② if $|A| = 0 \Rightarrow \infty$ sol exist

Note ① unique sol = Trivial sol. = Zero sol. always exist.

② ∞ sol = Non Trivial sol = Non Zero sol also exist

Q: Find K for which

MSQ
$$(3K-8)x+3y+3z=0$$
$$3x+(3K-8)y+3z=0$$
$$3x+3y+(3K-8)z=0$$

has Non Trivial Sol.

(a) $\frac{2}{3}$ (b) $\frac{11}{3}$ (c) $\frac{4}{3}$ (d) $\frac{8}{3}$

for Non Trivial Sol (∞ Sol) $\rightarrow |A|=0$

$$\begin{vmatrix} (3K-8) & 3 & 3 \\ 3 & (3K-8) & 3 \\ 3 & 3 & (3K-8) \end{vmatrix}=0 \longrightarrow \begin{vmatrix} (3K-2) & 3 & 3 \\ (3K-2) & (3K-8) & 3 \\ (3K-2) & 3 & (3K-8) \end{vmatrix}=0$$

$$(3K-2)\begin{vmatrix} 1 & 3 & 3 \\ 1 & (3K-8) & 3 \\ 1 & 3 & (3K-8) \end{vmatrix}=0$$

$$(3K-2)\begin{vmatrix} 1 & 3 & 3 \\ 0 & (3K-11) & 0 \\ 0 & 0 & (3K-11) \end{vmatrix}=0 \Rightarrow (3K-2)(3K-11)^2=0$$

$$K=\frac{2}{3}, \frac{11}{3}, \frac{11}{3}$$

The value of α for which the system of equation

PYQ

$$x + y + z = 0$$
$$y + 2z = 0$$
$$\alpha x + z = 0$$

has more than one solution is

(a) -1 (b) 0

(c) $\frac{1}{2}$ (d) 1

$|A| = 0$

$$\begin{vmatrix} 1 & 1 & 1 \\ 0 & 1 & 2 \\ \alpha & 0 & 1 \end{vmatrix} = 0$$

$1[1-0] - 0 + \alpha[2-1] = 0$

$1 + \alpha = 0$

$\alpha = -1$

M-II Expanding along R_3

$\alpha[2-1] - 0 + 1[1-0] = 0$

$\alpha + 1 = 0 \Rightarrow \alpha = -1$

HW Q / MSQ For the System to have Infinite Sol, which of the following is/are True

$px+qy+rz=0$

$qx+ry+pz=0$

$rx+py+qz=0$

(a) $p=q=r$ (By observation)

(b) $p+q+r=0$

(c) $p^3+q^3+r^3-3pqr=0$

(d) None

$|A|=0 \Rightarrow \begin{vmatrix} p & q & r \\ q & r & p \\ r & p & q \end{vmatrix}=0$

$\boxed{p^3+q^3+r^3-3pqr=0}$ Ans

$(p+q+r)\cdot\left[(p-q)^2+(q-r)^2+(r-p)^2\right]=0$

is $\boxed{p+q+r=0}$ or $\boxed{p=q=r}$ Ans

Q. Consider $\boxed{A_{m\times n} X_{n\times 1} = B_{m\times 1}}$ then which one is false ?

(a) if $m > n$, $B \neq 0$, $\rho(A) < \rho(A:B)$ then system has NO sol. (T)

(b) if $m = n$, $B = 0$, $|A| \neq 0$ then system has only Trivial sol. (T)

(c) if $m = 3, n = 5$, $B = 0$ then system has <u>also</u> Non Zero sol. (T)

(d) if $m = 5, n = 3$, $B = 0$ s.t $\rho(A) = 3$ then system has only zero sol. (T)

(e) if $m = n$, $B = 0$, then system has sol. (T) (obviously True)

(f) if $m > n$, $B = 0$ then System has Multiple sol. (false)

(g) if $m > n$, $B = 0$, $\boxed{\rho(A) < n}$ then system has Multiple sol. (True)

(h) Sun Rises from east (T) (obviously True)

Analysis (PODCAST) → Consider $\boxed{x+y+z=0}$ —— ① $\begin{bmatrix}1 & 1 & 1\end{bmatrix}_{1\times 3}\begin{bmatrix}x\\y\\z\end{bmatrix}_{3\times 1}=\begin{bmatrix}0\end{bmatrix}_{1\times 1}$

i.e. $A_{1\times 3}X_{3\times 1}=O_{1\times 1}$ then it's soln are;

$$X=\begin{bmatrix}x\\y\\z\end{bmatrix}=\underbrace{\begin{bmatrix}0\\0\\0\end{bmatrix}}_{\text{Trivial soln.}},\ \underbrace{\begin{bmatrix}1\\-1\\0\end{bmatrix},\begin{bmatrix}1\\0\\-1\end{bmatrix},\begin{bmatrix}2\\-1\\-1\end{bmatrix},\begin{bmatrix}4\\-4\\0\end{bmatrix},\begin{bmatrix}-7/2\\0\\7/2\end{bmatrix},\begin{bmatrix}3\\-2\\-1\end{bmatrix},\ldots\ldots}_{\text{Non Trivial soln's}}\ \infty \text{ soln.}$$

Null space

$$X_1=\begin{bmatrix}1\\-1\\0\end{bmatrix}\longrightarrow\begin{bmatrix}2\\-2\\0\end{bmatrix},\begin{bmatrix}1/3\\-1/3\\0\end{bmatrix},\begin{bmatrix}-0.2\\+0.2\\0\end{bmatrix}\cdots\cdots$$ But all are (LD) on X_1

$$X_2=\begin{bmatrix}1\\0\\-1\end{bmatrix}\longrightarrow\begin{bmatrix}4\\0\\-4\end{bmatrix},\begin{bmatrix}-\sqrt{5}\\0\\\sqrt{5}\end{bmatrix},\cdots\cdots$$ But all are (LD) on X_2

$$X_3=\begin{bmatrix}2\\-1\\-1\end{bmatrix}=X_1+X_2,\quad X_4=\begin{bmatrix}3\\-2\\-1\end{bmatrix}=2X_1+X_2\cdots$$ i.e. again all are (LD)

ie out of ∞ soln only X_1 & X_2 are LI & Rest are LD on them.

Nullity (Dimension of Nullspace) →

"the counting of L-I soln in any Homog system $\boxed{A_{m\times n} X_{n\times 1} = O_{m\times 1}}$ is called Nullity" & it is given as $N(A)$.

Rank-Nullity Th: Nullity = Number of Columns − Rank(A)

ie $\boxed{N(A) = N(\text{Columns}) - \rho(A)}$

Q find Nullity of $\boxed{x+y+z=0}$? Here $A = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix}_{1\times 3}$ so $\rho(A) = 1$.

Hence Nullity$(A) = 3 - 1 = 2$

Ie above system has two LI soln & Rest are LD on them.

PODCAST: Consider $\boxed{A_{m\times n} X_{n\times 1} = O_{m\times 1}}$

Row Space: set of all Linear Combinations of Row vectors of A is called Row space
& Dimension of Row Space = Max No. of LI Row vectors = $\rho(A)$

Column space (Range Space) set of all linear combinations of Column vectors of A is called Column space
& Dimension of Column space = Max No of L.I Column vectors = $\rho(A)$

Null space: set of all solutions of $\boxed{AX=0}$ is called Null space
& Dimension of Null space = Nullity = No. of LI Solutions in terms of X.

(*) $N(A) \perp R(A)$ i.e. Row space is $\perp^r$ to Null space (Col^n space)

"Every vector in Null space is orthogonal to every vector in Row space"

$\because AX = 0 \Rightarrow \begin{bmatrix} a_1 & a_2 & a_3 & \cdots & a_n \\ b_1 & b_2 & b_3 & \cdots & b_n \\ c_1 & c_2 & c_3 & \cdots & c_n \\ \vdots & \vdots & \vdots & & \vdots \\ d_1 & d_2 & d_3 & \cdots & d_n \end{bmatrix}_{m\times n} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_n \end{bmatrix}_{n\times 1} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix}_{m\times 1}$

$a_1x_1 + a_2x_2 + \cdots + a_nx_n = 0$ i.e. R_1 & X are orthogonal

again $b_1x_1 + b_2x_2 + \cdots + b_nx_n = 0$ i.e. R_2 & X " "

& so on ..... i.e. Hence proved.

Q: If every solⁿ of system $\boxed{A_{4\times 5}X = O}$ (1) is a scalar multiplication of $\begin{bmatrix}2\\-3\\4\\1\\2\end{bmatrix}$ then $\rho(A) = ?$

ATQ, No. of LI solⁿ of (1) $=$ one $= N(A)$

By Rank-Nullity Th: $\boxed{N(A) = N(C) - \rho(A)}$

$$1 = 5 - \rho(A) \Rightarrow \rho(A) = 4 \text{ Ans}$$

Solution set $$X = \underbrace{\begin{bmatrix}2\\-3\\4\\1\\2\end{bmatrix}}_{\text{LI}} \longrightarrow \underbrace{\begin{bmatrix}4\\-6\\8\\2\\4\end{bmatrix}, \begin{bmatrix}-2\\3\\-4\\-1\\-2\end{bmatrix}, \begin{bmatrix}1\\-1.5\\2\\0.5\\1\end{bmatrix} \text{ - - - - } \infty \text{ sol}^{n}\text{!}}_{\text{LD}}$$

The nullity of system of quations:

$$\begin{cases} x_1 + x_2 - x_3 + x_4 = 0 \\ 2x_1 + 3x_2 + x_3 + 4x_4 = 0 \\ 3x_1 + 2x_2 - 6x_3 + x_4 = 0 \end{cases}$$

(a) 1 (b) 2

(c) 3 (d) 4

$$A = \begin{bmatrix} 1 & 1 & -1 & 1 \\ 2 & 3 & 1 & 4 \\ 3 & 2 & -6 & 1 \end{bmatrix}_{3\times 4} \xrightarrow[R_3 - 3R_1]{R_2 - 2R_1} \begin{bmatrix} 1 & 1 & -1 & 1 \\ 0 & 1 & 3 & 2 \\ 0 & -1 & -3 & -2 \end{bmatrix} \xrightarrow{R_3 + R_2} \begin{bmatrix} 1 & 1 & -1 & 1 \\ 0 & 1 & 3 & 2 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$\rho(A) = 2$ & $N(\text{Column}) = 4$

So $N(A) = N(C) - \rho(A) = 4 - 2 = 2$

$$A_{3\times 4} X_{4\times 1} = [0]_{3\times 1} \Rightarrow X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} =$$

only two soln are LI & Rest are LD on them.

The number of linearly independent solutions of the system of equations

$$\begin{bmatrix} 1 & 0 & 2 \\ 1 & -1 & 0 \\ 2 & -2 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = O \text{ is equal to}$$

(a) 1 (b) 2

(c) 3 (d) 0

$$A = \begin{bmatrix} 1 & 0 & 2 \\ 1 & -1 & 0 \\ 2 & -2 & 0 \end{bmatrix}$$

$\because |A| = 0 \Rightarrow \rho(A) \neq 3$

i.e. $\rho(A) = 2$

$N(A) = N(C) - \rho(A)$

$= 3 - 2 = 1.$

Q. Solve: $\left.\begin{aligned} 2x+y+z&=0 \\ x+y&=0 \\ y-z&=0 \end{aligned}\right\}$ $A=\begin{bmatrix} 2 & 1 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & -1 \end{bmatrix} \longrightarrow \begin{bmatrix} 1 & 1 & 0 \\ 2 & 1 & 1 \\ 0 & 1 & -1 \end{bmatrix} \longrightarrow \begin{bmatrix} 1 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & 1 & -1 \end{bmatrix}$

$\longrightarrow \begin{bmatrix} 1 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$ $\rho(A)=2<$ No of variables

$\Rightarrow \infty$ sol exist.

& $N(A)=3-\rho(A)=3-2=1$.

$\Downarrow$

$A_{3\times 3}X_{3\times 1}=O_{3\times 1}$

$$\begin{bmatrix} 2 & 1 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & -1 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix}=\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\approx \begin{bmatrix} 1 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix}=\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} (x+y) \\ (-y+z) \\ 0 \end{bmatrix}=\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$x+y=0 \Rightarrow x=-k$

$-y+z=0 \Rightarrow y=z$ let $z=k$, then $y=k$.

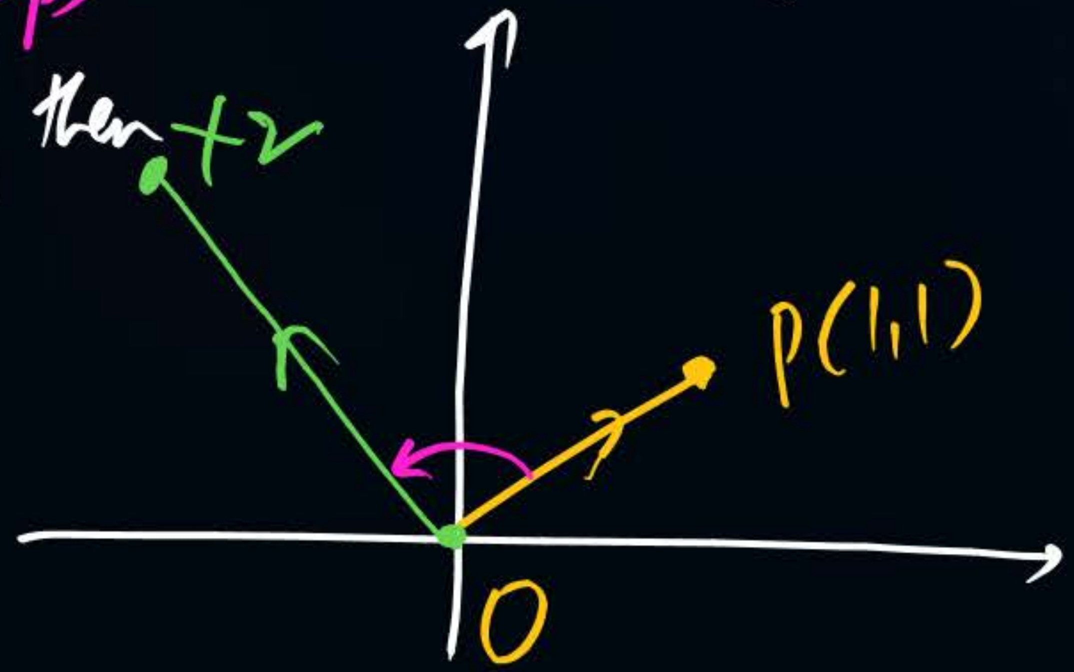
So $X=\begin{bmatrix} x \\ y \\ z \end{bmatrix}=\begin{bmatrix} -k \\ k \\ k \end{bmatrix}=k\begin{bmatrix} -1 \\ 1 \\ 1 \end{bmatrix}$, $k=$ arbitrary const.

ie ∞ sol exist in which only $\begin{bmatrix} -1 \\ 1 \\ 1 \end{bmatrix}$ is LI

Eigen Values / Eigen Vectors (100% they will ask Q.)

(Sp) (Sp)

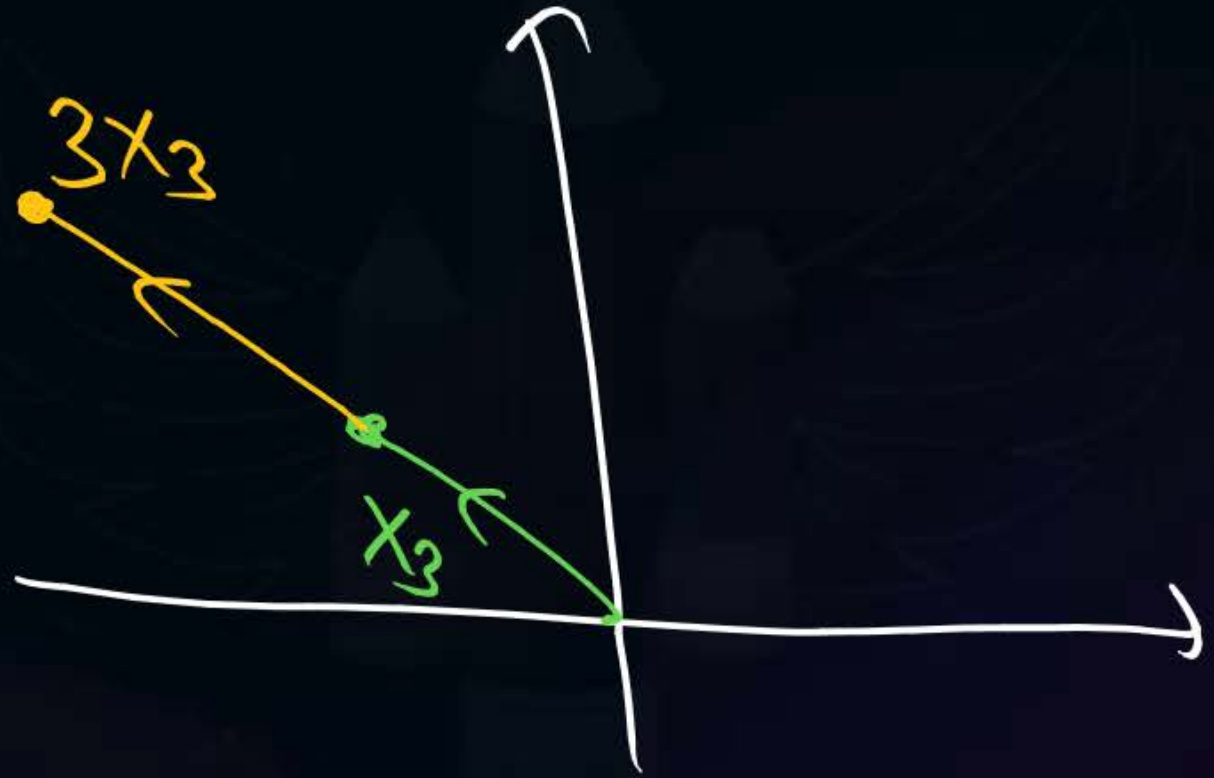
PODCAST: Consider $A=\begin{bmatrix}-1&-2\\0&3\end{bmatrix}$ & $X_1=\begin{bmatrix}1\\1\end{bmatrix}$ then



$$AX_1=\begin{bmatrix}-1&-2\\0&3\end{bmatrix}\begin{bmatrix}1\\1\end{bmatrix}=\begin{bmatrix}-3\\3\end{bmatrix}=X_2$$

again Consider $X_3=\begin{bmatrix}-1\\2\end{bmatrix}$.

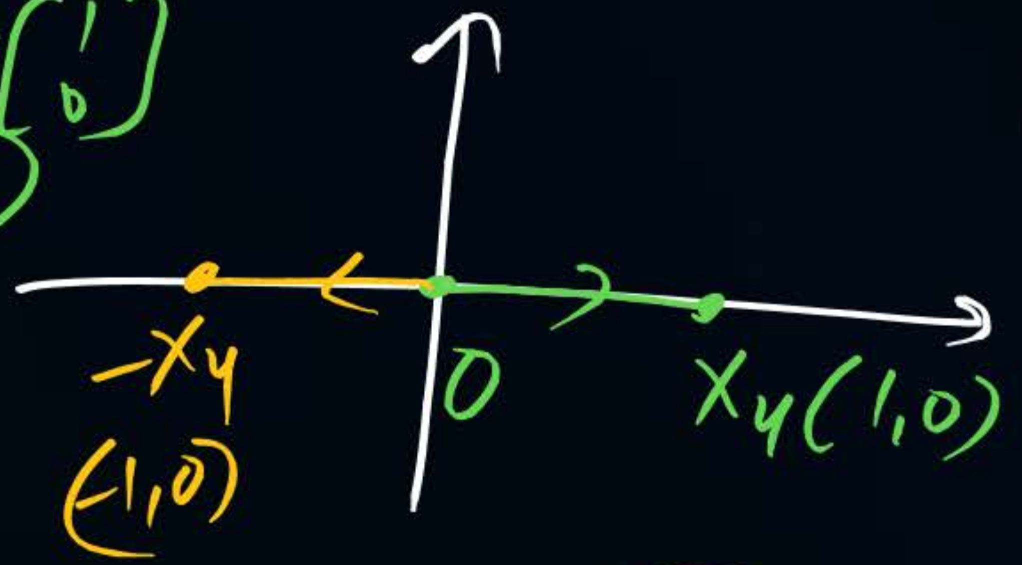
$$AX_3=\begin{bmatrix}-1&-2\\0&3\end{bmatrix}\begin{bmatrix}-1\\2\end{bmatrix}=\begin{bmatrix}-3\\6\end{bmatrix}=3\begin{bmatrix}-1\\2\end{bmatrix}=3X_3$$



$X_3=\begin{bmatrix}-1\\2\end{bmatrix}$ = Sp. vector & Sp Value = 3

Now consider $A=\begin{bmatrix}-1 & -2\\ 0 & 3\end{bmatrix}$, $X_4=\begin{bmatrix}1\\ 0\end{bmatrix}$ Sp. vector $= X_4 = \begin{bmatrix}1\\ 0\end{bmatrix}$ & Sp. value $= -1$

$$AX_4 = \begin{bmatrix}-1 & -2\\ 0 & 3\end{bmatrix}\begin{bmatrix}1\\ 0\end{bmatrix} = \begin{bmatrix}-1\\ 0\end{bmatrix} = -1\cdot\begin{bmatrix}1\\ 0\end{bmatrix} = -X_4$$



Consider $A=\begin{bmatrix}-1 & -2\\ 0 & 3\end{bmatrix}$, $X_5=\begin{bmatrix}0\\ 0\end{bmatrix} \Rightarrow AX_5 = \begin{bmatrix}-1 & -2\\ 0 & 3\end{bmatrix}\begin{bmatrix}0\\ 0\end{bmatrix} = \begin{bmatrix}0\\ 0\end{bmatrix} = X_5$

But X_5 is not an eigen vector ∵ it is a zero vector.

ie $\boxed{\text{E vector can not be zero vector.}}$

Consider $A = \begin{bmatrix}0 & 0 & 5\\ 0 & 0 & 0\\ 0 & 0 & 0\end{bmatrix}$, $X_6 = \begin{bmatrix}1\\ 0\\ 0\end{bmatrix}$ then $AX_6 = \begin{bmatrix}0 & 0 & 5\\ 0 & 0 & 0\\ 0 & 0 & 0\end{bmatrix}\begin{bmatrix}1\\ 0\\ 0\end{bmatrix} = \begin{bmatrix}0\\ 0\\ 0\end{bmatrix} = 0\cdot\begin{bmatrix}1\\ 0\\ 0\end{bmatrix} = 0\cdot X_6$

So X_6 is also special vector whose sp. value $= 0$

ie $\boxed{\text{E value can be zero also.}}$

Defn: Consider Sq. Mat $A_{n \times n}$ then Non Zero Vector X is called Eigen vector, corresponding to Eigen value λ (Real/Complex/Zero) if we are able to find a relationship of the type,

$$\boxed{AX = \lambda . X}$$

λ = Eigen value
X = Eigen vector.

LHS is the Multi of Two Matrices = RHS is the Scalar Multi in a Mat
(Tough) (Easy)

(*) Here we are considering Homogeneous system as follows

$$AX = \lambda X \Longrightarrow AX - \lambda X = 0 \Rightarrow \boxed{(A - \lambda I)X = 0}$$

So it will satisfy all the prop of Homog System.

(*) Consider $AX = \lambda X$

$$\boxed{(A - \lambda I)X = 0} \text{ — (1)}$$

$$MX = 0$$

↓

Non Zero Eigen Vector

Non Zero Solution

$\simeq \infty$ Solⁿs.

$$\rho(M) < n \text{ or } |M| = 0$$

$$\Rightarrow \rho(A - \lambda I) < n \text{ or } |A - \lambda I| = 0$$

So Necessary condition for the existence of Non Zero Eigen Vector is

$$\rho(A - \lambda I) < n \text{ or } \boxed{|A - \lambda I| = 0} \text{ — (1)}$$

Characteristic Equⁿ of A →

equⁿ (1) is Called C.Eq of A & Roots of this equⁿ i.e. Values of λ are called E. Values / E. Roots / Char Values / Char Roots / Latent Roots / Sp. Values.

eg: Find the E-Values of ① $A=\begin{bmatrix}2&1&1\\1&2&1\\0&0&1\end{bmatrix}$ ② $A=\begin{bmatrix}0&-1\\1&0\end{bmatrix}$ ③ $A=\begin{bmatrix}8&-6&2\\-6&7&-4\\2&-4&3\end{bmatrix}$

Sol: ① $A-\lambda I=\begin{bmatrix}2&1&1\\1&2&1\\0&0&1\end{bmatrix}-\lambda\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix}$

$$=\begin{bmatrix}(2-\lambda)&1&1\\1&(2-\lambda)&1\\0&0&(1-\lambda)\end{bmatrix}$$

≠ C-Equ^n But Char Mat.

Now C-Equ^n is $|A-\lambda I|=0$

$$\begin{vmatrix}(2-\lambda)&1&1\\1&(2-\lambda)&1\\0&0&(1-\lambda)\end{vmatrix}=0$$

$$(1-\lambda)\left[(2-\lambda)^2-1\right]=0$$

$$(1-\lambda)\left[(2-\lambda+1)(2-\lambda-1)\right]=0$$

$$\boxed{(\lambda-3)(\lambda-1)^2=0} \longrightarrow \text{C-Equ}^n \text{ of } A.$$

& $\lambda=3,1,1 \longrightarrow$ Char Values.

(2) $A = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$ then

C. Equ^n is $|A - \lambda I| = 0$.

$$\begin{vmatrix} (0-\lambda) & -1 \\ 1 & (0-\lambda) \end{vmatrix} = 0$$

$\lambda^2 + 1 = 0 \longrightarrow$ C. Equ^n

$\lambda = i \;\&\; -i$ E Values.

(3) $A = \begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$

C. Equ^n is $|A - \lambda I| = 0$

$$\begin{vmatrix} (8-\lambda) & 6 & 2 \\ -6 & (7-\lambda) & -4 \\ 2 & -4 & (3-\lambda) \end{vmatrix} = 0$$

HW

$\lambda(\lambda - 3)(\lambda - 15) = 0$ —— C. Equ^n

$\lambda = 0, 3, 15 \longrightarrow$ E Values

THANK - YOU

Tel:

$\boxed{\text{dr puneet sir pw}}$