



Doubt Clearing Session

Detailed Course 2.0 on Linear Algebra For IIT JAM' 23



Gajendra Purohit ✓

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System of linear equation

The system of m equations and n variables

$$a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n = b_1$$

$$a_{21}x_1 + a_{22}x_2 + \dots + a_{2n}x_n = b_2$$

.

.

$$a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mn}x_n = b_m$$

is called system of linear equation

It is denoted by $Ax = b$

Homogeneous system of linear equation : The system of equation $AX = b$ is called homogeneous iff $b = 0$.

Non - homogeneous system of linear equation : The system of equation $AX = b$ is called non - homogeneous iff $b \neq 0$.

And $[A : b]$ is augmented matrix

Consistency & inconsistency : Let $AX = b$ be a system of equation it is called consistent if it has a solution otherwise it is called inconsistent system of equation.

Note : Homogeneous system of equation $AX = 0$ always has a solution. So, $AX = 0$ is called consistent.

Solution space of homogeneous system : Let $AX = 0$ be a given homogeneous system then $\ker(A)$ is called solution space of this system.

Dimension of solution space : Let $A_{m \times n}$ is a coefficient matrix of system of linear equation. Then dimension of solution space = $\eta(A) = n - \rho(A)$

Note : $X = 0$ is known as trivial solution and any solution other than $X = 0$ is known as non-trivial solution

Analysis of solution of the homogeneous system of equation :

Consider the homogeneous system of equation $AX = 0$ of m -equation in n -variables.

$A = [a_{ij}]$ be $m \times n$ matrix with entries from $a_{ij} \in F$ (F is infinite field)

- (i) If $\ker(A) = \{0\}$ then system has trivial solution i.e. if $\eta(A) = 0$ then system has unique (trivial) solution.
- (ii) If $\ker(A) \neq \{0\}$ i.e. $\eta(A) \geq 1$ then system has infinite (non-trivial) solution.

- (3) If $|A| \neq 0$ then system has unique solution.
- (4) If $|A| = 0$ the system has infinite solution.
- (5) If number of equation (m) < number of variables then system always has non-trivial solution.
- (6) System has non-trivial solution iff it has infinite many solution.

Q.1 If system of linear equation

$$kx + y + 2z = 0$$

$$x - y - 2z = 0$$

$$x + y + 4z = 0$$

have a unique solution, then k is not equal to

(a) -1

(b) 0

(c) 1

(d) 2

Q.2. Let $M = \begin{bmatrix} \alpha & 1 & 1 \\ 1 & \beta & 1 \\ 1 & 1 & \gamma \end{bmatrix}$, $\alpha\beta\gamma = 1$, $\alpha, \beta, \gamma \in \mathbb{R}$ and

$x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \in \mathbb{R}^3$. Then $Mx = 0$ has infinitely many solution

if trace (M) is

(a) 0

(b) 1

(c) 2

(d) 3

Q.3 Consider the following system of three linear equation in three unknown x_1 , x_2 , & x_3 .

$$x_1 + x_2 + x_3 = 0$$

$$x_1 + kx_2 + 2x_3 = 0$$

$$2x_1 + 3x_2 + x_3 = 0$$

If system has infinitely many solution then value of k is

(a) 0

(b) 1

(c) 2

(d) 3

Q.4. Let A be a 5×4 matrix with real entries such that $Ax = 0$ iff $x = 0$ where x is a 4×1 vector and 0 is null vector. Then the rank of A is

(a) 4

(b) 5

(c) 2

(d) 1

Q.5 Consider a homogeneous system of linear equation $Ax = 0$ where A is an $m \times n$ real matrix and $n > m$. Then which of the following statements are always true?

- (a) $Ax = 0$ has a solution
- (b) $Ax = 0$ has no non-zero solution.
- (c) $Ax = 0$ has a non-zero solution
- (d) Dimension of the space of all solutions is

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Q.6. Let S be the solution space of system of linear equation

$$x + 2y + 3z = 0$$

$$3x + 4y + 4z = 0$$

$$7x + 10y + 12z = 0$$

Then dimension of S is

(a) 0

(b) 1

(c) 2

(d) 3

Non-homogeneous system of equation : A system of equation $Ax = b$ is called non-homogeneous iff $b \neq 0$.

Consistency & inconsistency : A non-homogeneous system $Ax = b$ is called consistency if it has a solution otherwise it is called inconsistent.

Augmented matrix : Let $Ax = b$ be a given system of equation then $[A : b]$ is called augmented matrix.

Necessary and sufficient condition for solution :

$Ax = b$ has a solution iff

- (i) $\rho(A : b) = \rho(A)$
- (ii) b is linear combination of c_1, c_2, \dots, c_n where c_i are column of A .

Note : If $\rho(A : b) \neq \rho(A)$ then $Ax = b$ has no solution.

Analysis of solution of non-homogeneous system of equation :

- (1) **Unique solution** : Let $Ax = b$ has a unique solution iff $\text{Ker}(A) = \{0\}$ i.e. $\eta(A) = 0$ and $\rho(A : b) = \rho(A)$
- (2) **Infinite solution** : A non-homogeneous system $Ax = b$ has infinite solution iff $\rho(A : b) = \rho(A)$ and $\eta(A) > 0$.
- (3) **No solution** :
If $\rho(A : b) \neq \rho(A)$
Then system $AX = b$ has no solution.

Q.1. Consider the following system

$$x + y + z + w = 4$$

$$x + 2y + 3z + 4w = 5$$

$$x + 3y + 5z + kw = 5$$

If the system has no solution then k is

(a) 4

(b) 5

(c) 7

(d) 6

Q.3. Consider the system

$$2x + ky = 2 - k$$

$$kx + 2y = k$$

$$ky + kz = k - 1$$

in three unknowns and one real parameter k . For which of the following values of k is the system of linear equation consistent?

(a) 1

(b) 2

(c) -1

(d) -2



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- Studied at M.Sc., NET, PhD(Algebra), MBA(Finance), BEd
- PhD, NET | Plus Educator For CSIR NET | Youtuber (260K+Subs.) | Director Pacific Science College |
- Lives in Udaipur, Rajasthan, India
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