



Types of Matrix and Their Functions

Detailed Course 2.0 on Linear Algebra For IIT JAM' 23



Gajendra Purohit ✓

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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.

Q1. 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

Q.2. The system of equation

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

$$2x + y - 4z = 4$$

$$5x - 14z = 10$$

- (a) has unique solution for $k = 2$
- (b) has infinitely many solution for $k = 2$
- (c) has no solution for $k = 2$
- (d) has unique solution for any $k \neq 2$

Q.3. Let $A = \begin{pmatrix} 2 & 0 & 5 \\ 1 & 2 & 3 \\ -1 & 5 & 1 \end{pmatrix}$. The system of linear equations

$AX = Y$ has a solution

(a) only for $Y = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$, $x \in \mathbb{R}$

(b) only for $Y = \begin{pmatrix} 0 \\ y \\ 0 \end{pmatrix}$, $y \in \mathbb{R}$

(c) only for $Y = \begin{pmatrix} 0 \\ y \\ z \end{pmatrix}$, $y, z \in \mathbb{R}$

(d) for all $Y \in \mathbb{R}^3$

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Q4. Let A be an $m \times m$ matrix with real entries and let x be an $m \times 1$ vector of unknowns. Now consider the two statements given below :

- I There exists non-zero vector $b_1 \in \mathbb{R}^m$ such that the linear system $Ax = b_1$ has no solution.
- II There exist non-zero vectors $b_2, b_3 \in \mathbb{R}^m$, with $b_2 \neq cb_3$ for any $c \in \mathbb{R}$, such that the linear systems $Ax = b_2$ and $Ax = b_3$ have solutions.

Which of the following statements are true?

- (a) II is true whenever A is singular
- (b) I is true whenever A is singular
- (c) Both I and II can be true simultaneously
- (d) If $m = 2$, then at least one of I and II is false.

Q.5. The system of equations :

$$1 \cdot x + 2 \cdot x^2 + 3 \cdot xy + 0 \cdot y = 6$$

$$2 \cdot x + 1 \cdot x^2 + 3 \cdot xy + 1 \cdot y = 5$$

$$1 \cdot x - 1 \cdot x^2 + 0 \cdot xy + 1 \cdot y = 7$$

- (a) has solution in rational numbers
- (b) has solutions in real numbers
- (c) has solutions in complex numbers
- (d) has no solution

Q.6 Let $m > 1$ and $n > 1$ be integers. Let A be an $m \times n$ matrix such that for some $m \times 1$ matrix b_1 , the equation $AX = b_1$ has infinitely many solutions. Let b_2 denote an $m \times 1$ different from b_1 . Then $AX = b_2$ has

- (a) infinitely many solutions for some b_2 .
- (b) a unique solution for some b_2 .
- (c) finitely many solutions for some b_2 .
- (d) no solution for some b_2 .

Q.7 Let A be an $n \times n$ real matrix. Let b be an $n \times 1$ vector. Suppose $Ax = b$ has no solution. Which of the following statements are true?

- (a) There exists an $n \times 1$ vector c such that $Ax = c$ has a unique solution
- (b) There exist infinitely many vectors c such that $Ax = c$ has no solution
- (c) If y is the first column of A then $Ax = y$ has a unique solution
- (d) $\det A = 0$



Q.8. Number of solution of system of linear equation

$$3x + 4y - z - 6w = 0$$

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

$$2x + y - 14z - 9w = 0$$

$$x + 3y + 13z + 3w = 0$$

(a) unique solution (b) two solution

(c) more than 2 but finite solution

(d) infinite solution





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