

EE5609 Assignment 10

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Abstract—This document solves problem based on solution of vector space.

Download all solutions from

https://github.com/abhishekt711/EE5609/tree/master/Assignment_10

1 PROBLEM

Consider the vectors in \mathbb{R}^4 defined by:

$$\alpha_1 = \begin{pmatrix} -1 \\ 0 \\ 1 \\ 2 \end{pmatrix}, \alpha_2 = \begin{pmatrix} 3 \\ 4 \\ -2 \\ 5 \end{pmatrix} \text{ and } \alpha_3 = \begin{pmatrix} 1 \\ 4 \\ 0 \\ 9 \end{pmatrix}.$$

Find a system of homogeneous linear equations for which the space of solutions is exactly the subspace of \mathbb{R}^4 spanned by the given three vectors.

2 SOLUTION

A system of linear equations is homogeneous if all of the constant terms are zero. It can be represented as,

$$\mathbf{A}\mathbf{X} = 0 \quad (2.0.1)$$

Let \mathbf{R} be a echelon matrix which is reduced to \mathbf{A} . Then the systems $\mathbf{A}\mathbf{X} = 0$ and $\mathbf{R}\mathbf{X} = 0$ have the same solutions. Here,

$$\mathbf{A} = \begin{pmatrix} -1 & 3 & 1 \\ 0 & 4 & 4 \\ 1 & -2 & 0 \\ 2 & 5 & 9 \end{pmatrix} \quad (2.0.2)$$

By operating column operation on \mathbf{A} , we get:

$$\begin{pmatrix} -1 & 3 & 1 \\ 0 & 4 & 4 \\ 1 & -2 & 0 \\ 2 & 5 & 9 \end{pmatrix} \xrightarrow{C_3=C_3-2C_1-C_2} \begin{pmatrix} -1 & 3 & 0 \\ 0 & 4 & 0 \\ 1 & -2 & 0 \\ 2 & 5 & 0 \end{pmatrix} \quad (2.0.3)$$

$$\xrightarrow{C_1=-C_1} \begin{pmatrix} 1 & 3 & 0 \\ 0 & 4 & 0 \\ -1 & -2 & 0 \\ -2 & 5 & 0 \end{pmatrix} \quad (2.0.4)$$

$$\xrightarrow{C_2=C_2-3C_1} \begin{pmatrix} 1 & 0 & 0 \\ 0 & 4 & 0 \\ -1 & 1 & 0 \\ -2 & 11 & 0 \end{pmatrix} \quad (2.0.5)$$

$$\xrightarrow{C_2=\frac{1}{4}C_2} \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -1 & \frac{1}{4} & 0 \\ -2 & \frac{11}{4} & 0 \end{pmatrix} \quad (2.0.6)$$

The basis vector is non zero vector which are given from 2.0.6,

$$\rho_1 = \begin{pmatrix} 1 \\ 0 \\ -1 \\ -2 \end{pmatrix}, \rho_2 = \begin{pmatrix} 0 \\ 1 \\ \frac{1}{4} \\ \frac{11}{4} \end{pmatrix} \quad (2.0.7)$$

ρ_1, ρ_2 forms the basis of the solution space. The required homogeneous matrix equation is given as:

$$\begin{pmatrix} x \\ y \\ z \\ w \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \\ -1 & \frac{1}{4} \\ -2 & \frac{11}{4} \end{pmatrix} \mathbf{X} \quad (2.0.8)$$