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A **linear transformation**, T:U→VT:U→V, is a function that carries elements of the vector space UU (called the **domain**) to the vector space VV (called the **codomain**), and which has two additional properties

1. T(u1+u2)=T(u1)+T(u2)T(u1+u2)=T(u1)+T(u2) for all u1,u2∈Uu1,u2∈U
2. T(αu)=αT(u)T(αu)=αT(u) for all u∈Uu∈U and all α∈C

$$A \begin{pmatrix} 0 & 1 & 3 \\ -1 & 0 & 2 \\ 4 & -2 & 1 \end{pmatrix} \quad B \begin{pmatrix} 4 & 2 & 1 \\ 3 & 1 & -1 \\ 2 & 0 & 1 \end{pmatrix} \quad C \begin{pmatrix} 4 & 3 & 0 \\ 6 & 1 & -1 \\ 5 & 2 & -4 \end{pmatrix}$$

$$D \begin{pmatrix} 0 & 1 & 3 \\ 1 & 0 & 2 \\ 4 & 2 & 1 \end{pmatrix} \quad E \begin{pmatrix} 3 & 3 & 0 \\ 2 & 1 & -1 \\ 1 & 3 & -1 \end{pmatrix}$$

i. LINEAR TRANSFORMATION OF A , IF VEXTOR x = (a,b,c)

$$A = \begin{pmatrix} 0 & 1 & 3 \\ -1 & 0 & 2 \\ 4 & -2 & 1 \end{pmatrix} \qquad x = \begin{pmatrix} a \\ b \\ c \end{pmatrix}$$

$$T(x) = a\begin{pmatrix} 0 \\ -1 \\ 4 \end{pmatrix} + b\begin{pmatrix} 1 \\ 0 \\ -2 \end{pmatrix} + c\begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} 0 \\ -a \\ 4 \end{pmatrix} + \begin{pmatrix} b \\ 0 \\ -2b \end{pmatrix} + \begin{pmatrix} 3 \\ c \\ 2 \end{pmatrix}$$

$$T(x) = \begin{pmatrix} 0 + b + 3c \\ -a + 0 + 2c \\ 4a - 2b + c \end{pmatrix}$$

Hence the transformation of $\begin{pmatrix} a \\ b \\ c \end{pmatrix}$ gives; $\begin{pmatrix} b + 3c \\ -a + 2c \\ 4a - 2b + \end{pmatrix}$

ii. LINEAR TRANSFORMATION OF B , IF VEXTOR x = (a,b,c)

$$B = \begin{pmatrix} 4 & 2 & 1 \\ 3 & 1 & -1 \\ 2 & 0 & 1 \end{pmatrix} \qquad x = \begin{pmatrix} a \\ b \\ c \end{pmatrix}$$

$$T(x) = a\begin{pmatrix} 4 \\ 3 \\ 2 \end{pmatrix} + b\begin{pmatrix} 2 \\ 1 \\ 0 \end{pmatrix} + c\begin{pmatrix} 1 \\ -1 \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} 4a \\ 3 \end{pmatrix} + \begin{pmatrix} 2b \\ b \\ \end{pmatrix} + \begin{pmatrix} c \\ -c \\ c \end{pmatrix}$$

$$T(x) = \begin{pmatrix} 4a + 2b + c \\ 3a + b - c \\ 2a + 0 + c \end{pmatrix}$$

Hence the transformation of $\begin{pmatrix} a \\ b \\ c \end{pmatrix}$ gives; $\begin{pmatrix} 4a + 2b + c \\ 3a + b - c \\ 2a + c \end{pmatrix}$

iii. LINEAR TRANSFORMATION OF C , IF VEXTOR x = (a,b,c)

$$C = \begin{pmatrix} 4 & 3 & 0 \\ 6 & 1 & -1 \\ 5 & 2 & -4 \end{pmatrix} \qquad x = \begin{pmatrix} a \\ b \\ c \end{pmatrix}$$

$$T(x) = a\begin{pmatrix} 4 \\ 6 \\ 5 \end{pmatrix} + b\begin{pmatrix} 3 \\ 1 \\ 2 \end{pmatrix} + c\begin{pmatrix} 0 \\ -1 \\ -4 \end{pmatrix}$$

$$\begin{pmatrix} 4 \\ a \\ 6 \end{pmatrix} + \begin{pmatrix} 3b \\ b \end{pmatrix} + \begin{pmatrix} 0 \\ -c \\ -4c \end{pmatrix}$$

$$T(x) = \begin{pmatrix} 4a + 3b + 0 \\ 6a + b - c \\ 5a + 2b - 4c \end{pmatrix}$$

Hence the transformation of $\begin{pmatrix} a \\ b \\ c \end{pmatrix}$ gives; $\begin{pmatrix} 0 & 1 & 3 \\ 1 & 0 & 2 \\ 4 & 2 & 1 \end{pmatrix}$

iv. LINEAR TRANSFORMATION OF D , IF VEXTOR x = (a,b,c)

$$D = \begin{pmatrix} 0 + b + 3c \\ a + 0 + 2c \\ 4a + 2b + c \end{pmatrix} \qquad x = \begin{pmatrix} a \\ b \\ c \end{pmatrix}$$

$$T(x) = a\begin{pmatrix} 0 \\ 1 \\ 4 \end{pmatrix} + b\begin{pmatrix} 1 \\ 0 \\ 2 \end{pmatrix} + c\begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} 0 \\ a \\ 4 \end{pmatrix} + \begin{pmatrix} b \\ 0 \\ 2b \end{pmatrix} + \begin{pmatrix} 3c \\ 2c \\ c \end{pmatrix}$$

$$T(x) = \begin{pmatrix} 4a + 3b \\ 6a + b - c \\ 5a + 2b - 4c \end{pmatrix}$$

Hence the transformation of $\begin{pmatrix} a \\ b \\ c \end{pmatrix}$ gives; $\begin{pmatrix} b + 3c \\ a + 2c \\ 4a + 2b + \end{pmatrix}$

v. LINEAR TRANSFORMATION OF E , IF VEXTOR x = (a,b,c)

$$E = \begin{pmatrix} 3 & 3 & 0 \\ 2 & 1 & -1 \\ 1 & 3 & -1 \end{pmatrix} \qquad x = \begin{pmatrix} a \\ b \\ c \end{pmatrix}$$

$$T(x) = a\begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix} + b\begin{pmatrix} 3 \\ 1 \\ 3 \end{pmatrix} + c\begin{pmatrix} 0 \\ -1 \\ -1 \end{pmatrix}$$

$$\begin{pmatrix} 3a \\ 2 \end{pmatrix} + \begin{pmatrix} 3b \\ b \\ 3b \end{pmatrix} + \begin{pmatrix} 0 \\ -c \\ -c \end{pmatrix}$$

$$T(x) = \begin{pmatrix} 3a + 3b + 0 \\ 2a + b - c \\ a - 3b - c \end{pmatrix}$$

Hence the transformation of $\begin{pmatrix} a \\ b \\ c \end{pmatrix}$ gives; $\begin{pmatrix} 3a + 3b + 0 \\ 2a + b - c \\ a - 3b - c \end{pmatrix}$