(ii) $u = \alpha_1 u_1 + \alpha_2 u_2 + \cdots + \alpha_n u_n$

Let $\alpha_1 = 1$, $\alpha_2 = \cdots = \alpha_n = 0$

$u = u_1$

$T(u_1) = v_1$

$\vdots$

(iii) Let T is not unique.

Let $\exists$ another map $F \neq T$ such that

$F(u) = \alpha_1 v_1 + \alpha_2 v_2 + \cdots + \alpha_n v_n$

Now, $F(u) - T(u) = (\alpha_1 v_1 + \alpha_2 v_2 + \cdots + \alpha_n v_n) - (\alpha_1 v_1 + \alpha_2 v_2 + \cdots + \alpha_n v_n)$

$= 0$

$\Rightarrow F(u) = T(u)$