2.17)

$$A_{\Phi} = \begin{bmatrix} 3 & 2 & 1 \\ 1 & 1 & 1 \\ 1 & -3 & 0 \\ 2 & 3 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 3 & 2 & 1 \\ 1 & 1 & 1 \\ 1 & -3 & 0 \\ 2 & 3 & 1 \end{bmatrix}\begin{array}{l} \text{swap with } R_2 \\ \\ \\ \\ \end{array} \rightsquigarrow \begin{bmatrix} 1 & 1 & 1 \\ 3 & 2 & 1 \\ 1 & -3 & 0 \\ 2 & 3 & 1 \end{bmatrix}\begin{array}{l} \\ -3R_1 \\ -R_1 \\ -2R_1 \end{array} \rightsquigarrow \begin{bmatrix} 1 & 1 & 1 \\ 0 & -1 & -2 \\ 0 & -4 & -1 \\ 0 & 1 & -1 \end{bmatrix}\begin{array}{l} \\ \cdot -1 \\ -4R_2 \\ +R_2 \end{array} \rightsquigarrow \begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 7 \\ 0 & 0 & -3 \end{bmatrix}\begin{array}{l} \\ \\ \cdot \frac{1}{7} \\ +\frac{3}{7}R_3 \end{array}$$

$$\rightsquigarrow \begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

$\text{rk}(A_{\Phi}) = 3$

$\ker(\Phi) = [0,0,0]^T$ $\because$ all the column vectors of A_{Φ} are linearly independent.

$\text{Im}(\Phi) = \{ [(3x_1 + 2x_2 + x_3), (x_1 + x_2 + x_3), (x_1 - 3x_2), (2x_1 + 3x_2 + x_3)]^T \mid x_1, x_2, x_3 \in \mathbb{R} \}$