2) b. v_1, v_2, v_3, v_4 are vectors in $\mathbb{R}^3$. The number of vectors (4) exceeds the dimension of $\mathbb{R}^3$ (3). Thus, these vectors are linearly dependent.
Express on vector as a linear comb. of the others:

$$c_1 v_1 + c_2 v_2 + c_3 v_3 + c_4 v_4 = 0$$

This eq. is equivalent to the following system:

$$\begin{array}{c} \begin{array}{cccc} c_2 & c_2 & c_3 & c_4 \\ \downarrow & \downarrow & \downarrow & \downarrow \end{array} \\ \left[\begin{array}{cccc|c} 1 & 2 & -1 & 0 & 0 \\ 2 & 1 & 0 & 3 & 0 \\ -1 & 3 & 4 & 1 & 0 \end{array}\right] \end{array} \xrightarrow{RREF} \left[\begin{array}{cccc|c} 1 & 0 & 0 & 32/19 & 0 \\ 0 & 1 & 0 & -7/19 & 0 \\ 0 & 0 & 1 & 18/19 & 0 \end{array}\right]$$

nonpivot col.

$$\begin{cases} c_4 = t, \\ c_3 = -\dfrac{18}{19} t \\ c_2 = \dfrac{7}{19} t \\ c_1 = -\dfrac{32}{19} t \end{cases} \qquad \text{Pick } t = 19: \quad \begin{cases} c_4 = 19 \\ c_3 = -18 \\ c_2 = 7 \\ c_1 = -32 \end{cases}$$

We have $-32 v_1 + 7 v_2 - 18 v_3 + 19 v_4 = 0$

This implies: $$v_4 = \frac{32}{19} v_1 - \frac{7}{19} v_2 + \frac{18}{19} v_3$$

The space spanned by v_1, v_2, v_3, v_4 has basis $\{v_1, v_2, v_3\}$ because the first 3 columns in the RREF are pivot. This space has dimension 3.

4) $$A \xrightarrow{RREF} \begin{bmatrix} 1 & 0 & -2 & 0 \\ 0 & 1 & 5/2 & 1/2 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

nonpivot cols.

$$x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} \qquad x_4 = t$$

$$x_3 = s$$

$$x_2 = -\tfrac{5}{2} s - \tfrac{1}{2} t, \quad x_1 = 2s$$

$$x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = \begin{bmatrix} 2s \\ -5/2\, s - \frac{1}{2} t \\ s \\ t \end{bmatrix} = s \begin{bmatrix} 2 \\ -5/2 \\ 1 \\ 0 \end{bmatrix} + t \begin{bmatrix} 0 \\ -1/2 \\ 0 \\ 1 \end{bmatrix}$$

The null space of A is the space spanned by vectors

$$v_1 = \begin{bmatrix} 2 \\ -5/2 \\ 1 \\ 0 \end{bmatrix} \quad \text{and} \quad v_2 = \begin{bmatrix} 0 \\ -1/2 \\ 0 \\ 1 \end{bmatrix}$$

These vectors are linearly independent, thus form a basis for $N(A)$.

$\dim N(A) = 2.$