1. Consider the following matrices and describe what linear transformations they define.

$$\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix} \quad \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix} \quad \begin{pmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

2. Find the matrix of the transformation of symmetry with respect to the line given by vector $(1, 2)$ in $\mathbb{R}^2$.

3. Find the matrix of the rotation in $\mathbb{R}^3$ with respect to the line given by vector $(1, 1, 1)$ to the angle α.

4. Find the rank of the matrix

$$\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 2 & 4 & 6 \end{pmatrix}$$

5. (a) Prove that the set of solutions of a homogeneous system of linear equations $L = \{\vec{x} : A\vec{x} = \vec{0}\}$ is a linear space.

   (b) Suppose $rk(A) = k$, where A is an $n \times m$ matrix. What is the dimension of the space L? (Hint: use the geometric intuition and Gaussian elimination method.)