Problem 1. Use Gaussian elimination to transform the augmented matrix of the following system into the echelon form. Use it to find the solutions, if there exist any.

\[
\begin{align*}
  x + y - 2z &= 0, \\
  3x + 5y - 2z &= 8.
\end{align*}
\]

Problem 2. (1) Find the inverse of the following matrix:

\[
A = \begin{bmatrix}
  0 & 2 & 1 \\
  1 & 0 & 1 \\
  1 & -1 & 0
\end{bmatrix}.
\]

(2) Use the inverse of \(A\) to solve the system (another way of solving it will not be counted)

\[
\begin{align*}
  2y + z &= 1, \\
  x + z &= 0, \\
  x - y &= -1.
\end{align*}
\]

Problem 3. Use Cramer’s rule to determine the unique solution to the system \(Ax = b\) for the following matrix and vector:

\[
A = \begin{bmatrix}
  4 & 1 & 3 \\
  2 & -1 & 5 \\
  2 & 3 & 1
\end{bmatrix}, \quad b = \begin{bmatrix}
  5 \\
  7 \\
  2
\end{bmatrix}.
\]

Problem 4. Determine whether or not the set

\[
S = \{(x, y) \in \mathbb{R}^2 : x^2 + y^2 \leq 1\}
\]

is a subspace of \(\mathbb{R}^2\). Justify your answer.

Problem 5. An object of mass 2 kg, resting on a table next to a wall, is attached to the wall by a spring. A force of 8 N is applied to the mass, stretching the spring and moving the mass 1/2 m from its equilibrium position. The object is then released. Suppose the resistance to the motion is numerically equal to 8 times the instantaneous velocity.

(1) Set up an IVP governing the motion of the mass.
(2) Determine the position of the mass at any time $t$.

(3) At what time does the mass first pass through the equilibrium position and heading away from the wall?