1. Find all solutions of the system of equations

\[
\begin{align*}
x + y + z &= 1 \\
3x + y - z &= 0 \\
2x + y &= 1.
\end{align*}
\]

2. Prove that

\[e^A + I = 0\]

where

\[A = \begin{pmatrix} 0 & \pi \\ -\pi & 0 \end{pmatrix}, \quad I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}, \quad 0 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}.\]

3. Suppose \(V\) is a finite-dimensional inner product space and that \(w \in V\) with \(w \neq 0\). Define \(T\) by

\[Tu = \langle u, w \rangle \frac{w}{\|w\|^2}.\]

A. Show that \(T\) is linear.

B. Calculate the trace of \(T\).

C. Find the minimal and characteristic polynomials for \(T\).

4. Suppose that \(Ax = b\), where \(A\) is a 2x2 matrix and \(b\) is a 2-vector, has more than one solution. Describe a method to find the smallest solution, i.e., to find the minimum of \(\|x\|\) over all solutions to \(Ax = b\).