PROBLEM 1: (5 points) Prove that all similar matrices have the same eigenvalues.

PROBLEM 2: (5 points) Given matrix
\[
A = \begin{pmatrix}
3 & 2 \\
2 & 3 \\
\end{pmatrix}
\]
use Cayley-Hamilton theorem to compute \( A^2 \).

PROBLEM 3: (5 points) For the general scalar time varying linear differential system
\[
dx/dt = \alpha(t)x,
\]
find the scalar transition matrix.

PROBLEM 4: (5 points) Let \( \Phi(t, \tau) \) be the transition matrix for the autonomous system
\[
dx/dt = A(t)x,
\]
find the solution for the system \( dx/dt = A(t)x + B(t)u \).

PROBLEM 5: (10 points) State and prove the rank condition for total controllability for the LTI system \( dx/dt = Ax + Bu \).

PROBLEM 6: (10 points) State and prove the separation principle for LTI systems.