Answer the following 4 questions, 4 points each. Show all work. Closed book, no calculators. Academic integrity on the part of each student is presumed. Violations will be dealt with swiftly and justly.

1. Solve the equation:
   
   \[ \dot{x} + x \tan^2 t = e^{-\tan t}, \quad -\pi/2 < t < \pi/2, \]
   
given the initial value \( x(0) = -1 \).

2. Verify that one solution to the equation:
   
   \[ t^2 \ddot{x} - t(t + 2)\dot{x} + (t + 2)x = 0, \quad t > 0, \]
   
is \( x = t \). Find the general solution.

3. Find the solution to the equation \( \dot{x} = Ax \) satisfying \( x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \), where
   
   \[ A = \begin{bmatrix} 1 & -4 \\ -1 & -2 \end{bmatrix}. \]

4. Solve the equation
   
   \[ \dot{x} = Ax + \begin{bmatrix} t^2 \\ t \end{bmatrix}, \]
   
   with the initial value \( x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \), where
   
   \[ A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}. \]