1. Put the following matrix in canonical form.

\[
\begin{pmatrix}
3 & -2 & 1 \\
1 & 0 & -1 \\
-1 & 1 & 1 \\
\end{pmatrix}
\]
2. Consider the system

\[ X' = AX, \quad A = \begin{pmatrix} a & 0 & b \\ 0 & b & 0 \\ -b & 0 & a \end{pmatrix} \]

Sketch the regions in the \(ab\)-plane where this system has different types of phase portraits.
3. a) Define topologically conjugate systems.

b) Are the following two flows conjugate? If yes then find a conjugacy.

\[ X' = \begin{pmatrix} 3 & 1 \\ 0 & -1 \end{pmatrix} X, \quad Y' = \begin{pmatrix} -3 & 2 \\ 0 & 1 \end{pmatrix} Y, \]
4. a) Suppose \( X' = AX \) where \( A \) is a 3 \( \times \) 3 matrix whose eigenvalues are \(-2, \pm i\). Describe the flow.

b) What if the eigenvalues of \( A \) are \( \pm 2, 1 \)?
5. Consider the forced harmonic oscillator

\[ x'' + 4x' + 4x = \sin 2t \]

Find its periodic solutions.