1. Find the general solution of the following system of differential equations,
\[
\frac{dX}{dt} = BX, \quad \text{where } X(t) \in \mathbb{R}^3 \text{ and } B = \begin{bmatrix} -1 & -4 & -4 \\ 2 & 4 & 2 \\ 0 & 1 & 3 \end{bmatrix}.
\]

2. Find the general solution of the following system of differential equations,
\[
\frac{dX}{dt} = CX, \quad \text{where } X(t) \in \mathbb{R}^3 \text{ and } C = \begin{bmatrix} 0 & -2 & -2 \\ 3 & 6 & 4 \\ -2 & -3 & -1 \end{bmatrix}.
\]

3. Give three linearly independent solutions to the system of differential equations defined in question 1 above. Show that these solutions are indeed linearly independent.

4. Give three linearly independent solutions to the system of differential equations defined in question 2 above. Show that these solutions are indeed linearly independent.

5. In each case below, find a $2 \times 2$ matrix $M$ whose entries are all non-zero, and which satisfies the given property.
   (a) The eigenvalues of $M$ are 3 and 5.
   (b) The eigenvalues of $M$ are $-3$ and 2.
   (c) The matrix $M$ has an eigenvalue $\lambda = -2$ of multiplicity 2, but the corresponding (genuine) eigenspace is one-dimensional.

6. Let $M$ be the matrix you found in question 5.(c) above.
   (a) Write down the general solution to
   \[
   \frac{dX}{dt} = MX, \quad X(t) \in \mathbb{R}^2.
   \]
   (b) Would you say that the fixed point of this system, $X_0 = (0,0)^T$, is stable or unstable? Justify your answer.

7. For each part below, write down a system of differential equations of the form
   \[
   \frac{dX}{dt} = MX, \quad X(t) \in \mathbb{R}^2,
   \]
   where the $2 \times 2$ matrix $M$ has constant coefficients, and which satisfies the given property.
   (a) All solutions with initial conditions different from $(0,0)^T$ move away from the origin $(0,0)^T$. Justify your answer.
   (b) There is a non-trivial set of initial conditions such that the solution converge towards the origin, $(0,0)^T$, and there is a set of initial conditions such that the solution moves away from the origin. Justify your answer.