1) (18 pts) Let

\[
A = \begin{pmatrix} 1 & 2 \\ 10 & -1 \end{pmatrix}, \quad B = \begin{pmatrix} 2 & 1 \\ 3 & -4 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & -3 & 5 \\ 2 & 4 & 6 \end{pmatrix}
\]

Find \( A + 2B \), \( AB \), and \( C^T B \).
2) (18 pts) Solve by the Gauss–Jordan procedure:

\[
\begin{align*}
    x + 3y + 2z &= 5 \\
    2x + 8y + 3z &= 2 \\
    2x + 7y + 4z &= 8.
\end{align*}
\]
3) (18 pts) Find the determinant of the matrix

\[
A = \begin{pmatrix}
1 & 0 & 3 & 4 \\
3 & 1 & 0 & 2 \\
0 & 3 & 1 & 4 \\
1 & 2 & 0 & 1
\end{pmatrix}.
\]
4) (18 pts) A transformation $T(v) = Av$ is given by the matrix

$$A = \begin{pmatrix} 5 & 2 & 18 \\ 0 & 1 & 4 \\ 4 & 1 & 12 \end{pmatrix}.$$ 

Find the kernel and the image of $T$ and their dimensions.
5) (18 pts) Solve the initial value problem:

\[ y' = 2x \sec y, \quad y(1) = 0. \]
6) (18 pts) In \( RL \)-circuit the current \( I \) satisfies the equation

\[
L \frac{dI}{dt} + RI = E(t).
\]

Find the current at \( t = 1 \) if the resistance \( R \) is \( \cos t \) ohms, the inductance \( L \) is 1 henry, \( E(t) = \cos t \) volt, and the initial current is 1.
7) (18 pts) Solve the differential equation: \( y'' - 3y' + 2y = \cos t. \)
8) (18 pts) Use the Laplace transform to solve the differential equation \( y' + y = \text{step}(t - 1) \).
9) (18 pts) Solve the initial value problem:

\[ x' = \begin{pmatrix} 4 & 2 \\ 3 & -1 \end{pmatrix} x, \quad x(0) = \begin{pmatrix} 5 \\ -1 \end{pmatrix}. \]
10) (20 pts) Solve the system

\[ x' = \begin{pmatrix} 4 & 2 \\ 3 & -1 \end{pmatrix} x + \begin{pmatrix} \dot{t} \\ 0 \end{pmatrix}. \]
11) (18 pts) Find all equilibrium points of the given systems and classify their stability and geometry:

\[ x' = x - 2y \]
\[ y' = 4x - x^3 \]