1. Solve the linear differential equation \( y'' + 2y = e^{2x} \). (10%)

2. Solve the linear system of equations. (10%)
\[
\begin{align*}
-\text{x}_1 + \text{x}_2 + 2\text{x}_3 &= 1 \\
\text{x}_2 - \text{x}_3 + \text{x}_4 &= 2 \\
-\text{x}_1 + 3\text{x}_2 + 4\text{x}_4 &= 4
\end{align*}
\]

3. Solve \( y'' + 9y = 3x^2 + \frac{8}{3} \). (10%)

4. Given \( \mathbf{A} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & -1 \\ 0 & -1 & 1 \end{pmatrix} \) (1) Find the eigenvalues of \( \mathbf{A} \). (2) Compute \( \mathbf{A}^8 \). (10%)

5. Experimental show that the time rate of change of the temperature of a body is proportional to the difference between the temperature of a body and the temperature of the surrounding medium. Please set up a mathematical model to represent this experimental result. (5%)

6. LRC-series electrical circuit shown in Figure 1. Please set up a mathematical model to represent this circuit. (5%)

7. Let \( \vec{F}(x, y) = (2x + e^{-y})\vec{i} + (4y - xe^{-y})\vec{j} \) (1) Verify that \( \vec{F} \) is conservative. (2) Find the work done by the force \( \vec{F} \) along the indicated curve. See Figure 2. (10%)

8. Given \( f(t) = \begin{cases} 0 & t < 2 \\ t^2 + 6 & t \geq 2 \end{cases} \), find \( L[f(t)] \). (10%)

9. List an example to explain the application of Fourier series. (10%)

10. List an example to explain the application of Laplace transform. (10%)

11. Solve heat equation \( \frac{\partial u}{\partial t} = \beta^2 \frac{\partial^2 u}{\partial x^2} \) subject to the following conditions.
\[
\begin{align*}
u(0, t) &= u(a, t) = 0 & t > 0. \\
u(x, 0) &= h(x) & 0 < x < a.
\end{align*}
\]