1. Solve following non-homogeneous differential system:  \( (15\%) \)
\[
\frac{dx}{dt} = -2x + y \\
\frac{dy}{dt} = -4x + 3y + 10\cos t
\]

2. Let \( f(x, y, z) \) be a harmonic function in some domain \( D \). Show that the integral of the normal derivative of the function \( f \) over any piecewise smooth closed orientable surface \( S \) in \( D \) is zero. \( (15\%) \)

3. Solve following partial differential equation:  \( (20\%) \)
\[
x \frac{\partial u}{\partial x} + \frac{\partial u}{\partial t} = xt, \quad u(x, 0) = 0 \text{ if } x \geq 0, \quad u(0, t) = 0 \text{ if } t \geq 0.
\]

4. If a plane curve is represented in the form \( y = f(x), z = 0 \), show that its length between \( x = a \) and \( x = b \) is  \( (15\%) \)
\[
l = \int_a^b \left[ 1 + \left( \frac{dy}{dx} \right)^2 \right]^{1/2} dx
\]

5. Heat will flow in the direction of maximum gradient of temperature decay. If a temperature potential can be represented by \( T = \cos x \cosh y \),
   (1) Find the direction of heat flow at a point of \( (\pi/2, 2) \). \( (7\%) \)
   (2) Find the possible positions where the heat flows in the vertical direction. \( (8\%) \)

6. (1) Find the Fourier series of \( f(t) = t + \pi, -\pi < x < \pi, f(t) = f(t + 2\pi) \). \( (12\%) \)
(2) If a spring system under an external force of \( f(t) \) can be represented by
\[
y'' + \omega^2 y = f(t), \text{ please find the particular solution only.} \quad (8\%)
\]

Note: Fourier series
\[
a_0 = \frac{1}{2L} \int_{-L}^{L} f(t) dt, \quad a_n = \frac{1}{L} \int_{-L}^{L} f(t) \cos \frac{n\pi t}{L} dt, \quad b_n = \frac{1}{L} \int_{-L}^{L} f(t) \sin \frac{n\pi t}{L} dt
\]