1. Define an exact differential equation. For the following equation find value of $A$ such that the equation is exact and solve that equation

\[(x^2 + 3xy)dx + (Ax^2 + 4y)dy = 0.\]

Solve the differential equation $4y = x^2 + p^2$.

2. Given that $y = x^2$ and $y = x^5$ are solution of the corresponding homogeneous equation of the differential equation

\[x^2 \frac{d^2y}{dx^2} - 6x \frac{dy}{dx} + 10y = 3x^4 + 6x^3.\]

Using this, find general solution of this non-homogeneous equation.

3. Solve the following system of equations

\[\frac{dx}{dt} + \frac{dy}{dt} - x - 3y = e^t,\]
\[\frac{dx}{dt} + \frac{dy}{dt} + x = e^{3t}.\]

4. Solve the differential equation

\[x^3 \frac{d^3y}{dx^3} - x^2 \frac{d^2y}{dx^2} + 2x \frac{dy}{dx} - 2y = x^3.\]

Solve initial value problem

\[\frac{d^2y}{dx^2} - 6 \frac{dy}{dx} + 8y = 0, \quad y(0) = 1, \quad y'(0) = 6.\]

5. Find the integral of $q = (z + px)^2$ using Charpit’s Method.

Eliminate the arbitrary function $f$ from the equation

\[z = x + y + f(xy).\]

6. Reduce the equation

\[\frac{\partial^2 z}{\partial x^2} = \frac{\partial^2 z}{\partial y^2}\]

to canonical form.