1) Reduction of order Method
- Identify if it is homogenous or non-homogeneous
- Find a second solution of the given differential equation by the method of reduction of order
- Identify if $y_1$ and $y_2$ are fundamental set of solutions? Hint: Compute Wronsian

$$(1 - x^2)y'' - 2xy' + 2y = 0, \quad -1 < x < 1, \quad y_1(x) = x$$

2) Existence and Uniqueness of Solutions
Without solving the given initial value problem, what is the largest interval in which a unique solution is guaranteed to exist?
   a) $\sqrt{16 - t^2} \ y'' + \ln(t + 1) \ y' + \cos(t) \ y = 0, \quad y(0) = 2, \quad y'(0) = 0$

   b) Same equation but initial conditions: $y(-12.5) = 1, y'(-12.5) = 4$

3) Separable Equations
   Solve the following differential equation:
   a) $(3y^3 + 3y\cos y + 1)y' + \frac{(2x+1)y}{1+x^2} = 0$
4) Exact Equations

a) Find the value of $b$ for which the following equation is exact, and then solve it using the method of exact equation.

$$(xy^2 + bx^2y)dx + (x + y)x^2dy = 0$$

b) Solve the following equation using the method of exact equation

$$\left(\frac{x^2}{y} + \frac{3y}{x}\right) y' = -\left(3x + \frac{6}{y}\right)$$