1. State the order of the ordinary differential equation $x \frac{d^3y}{dx^3} - \left( \frac{dy}{dx} \right)^4 + y = 0$. Determine whether the equation is linear or nonlinear and give a reason.

2. Solve the following differential equation $\frac{dy}{dx} + y = f(x)$, $y(0) = 0$ where

$$f(x) = \begin{cases} 
1, & 0 \leq x \leq 1 \\
0, & x > 1
\end{cases}$$
3. Verify that \( y = e^{-x^2} \int_0^x e^t \, dt + ce^{-x^2} \) is a one parameter family of solutions of \( 2y' + 4xy = 2 \).

4. Find values of \( m \) so that the function \( y = e^{mx} \) is a solution of \( 2y'' + 7y' - 4y = 0 \).
5. Given that \( y = \frac{1}{e^x + c} \) is a one parameter family of a first order differential equation. Find a solution of the first order Initial Value Problem which has the differential equation and the condition \( y(-2) = \frac{1}{2} \). Then give the largest interval \( I \) over which the solution is defined.

6. Determine whether the theorem of existence and uniqueness will guarantee that the differential equation \( y' = \sqrt{y - 1} \) possesses a unique solution through the point \((-1, 1)\). What about through the point \((1, -1)\)?
7. Solve the following differential equations:

(a) \[ \frac{dy}{dx} = \frac{xy+2y-x-2}{x+y-3y+x-3} \]

(b) \[ x \frac{dy}{dx} + 4y = x^3 - x \]