(1) [4] Determine the order of the given differential equation; also state whether the equation is linear or nonlinear:
   (a) \( t^2 \frac{d^2 y}{dt^2} + t \frac{dy}{dt} - 4y = t^3 \)
       Solution: second-order, linear
   (b) \( \frac{d^3 v}{dt^3} + v \frac{dv}{dt} + 4v = \cos(t) \)
       Solution: third-order, nonlinear

(2) [6] Solve the given initial-value problems:
   (a) \( \frac{dy}{dx} = e^x, \quad y(0) = -2 \)
       Solution: This problem is separable. Its separated form is
       \[ 2y \, dy = e^x \, dx. \]
       Integrating both sides yields
       \[ y^2 = e^x + c. \]
       Applying the initial condition gives
       \((-2)^2 = e^0 + c,
       which implies \( c = 4 - 1 = 3 \). The solution is therefore
       \[ y = -\sqrt{e^x + 3}, \quad \text{for every } x, \]
       where the negative root is taken to satisfy the initial condition.
   (b) \( t \frac{dz}{dt} = 5t^2 - 3z, \quad z(1) = 5 \)
       Solution: This problem is linear. Its normal form is
       \[ \frac{dz}{dt} + \frac{3}{t} \, z = 5t. \]
       An integrating factor is \( e^{A(t)} \) where \( A'(t) = 3/t \). Setting \( A(t) = 3 \log(t) \), we find
       that \( e^{A(t)} = t^3 \). Hence, the problem has the integrating factor form
       \[ \frac{d}{dt} \left( t^3 \, z \right) = t^3 \cdot 5t = 5t^4. \]
       Integrating both sides yields
       \[ t^3 \, z = t^5 + c. \]
       Applying the initial condition gives
       \[ 1^3 \cdot 5 = 1^5 + c, \]
       which implies \( c = 5 - 1 = 4 \). The solution is therefore
       \[ z = t^2 + \frac{4}{t^3}, \quad \text{for every } t > 0. \]