Problem 1: Consider a liquid storage tank with a nonlinear resistance in the outlet flow rate \( F = 20\sqrt{h} \), \( h \) = liquid level, with the following values for the process parameters:
Area \( A = 1 \text{ ft}^2 \),
Steady state liquid level \( h_s = 9 \text{ ft} \),
Steady state for the inlet flow rate \( F_s = 60 \text{ ft}^3/\text{min} \)

a) Compute and plot the response of the nonlinear and linearized process models for
i) 10\% decrease in the inlet flow rate and ii) 85\% decrease in the inlet flow rate
(Use \texttt{ode45 from Matlab to compute the solution to the nonlinear ODE})

b) Comment on the nature of the responses for the two cases and the validity of the linearized process model.

Problem 2: Calculate the Laplace transform of the function: \( f(t) = (t-1)^2 \)

Problem 3: Find the time-domain solution for the following differential equation using Laplace transforms:
\[
\frac{d^2 x}{dt^2} + 5\frac{dx}{dt} + 6x = u(t)
\]
\[
\frac{dx}{dt}(0) = x(0) = 0
\]
where \( u(t) \) is the unit ramp function. Before you invert, comment on the qualitative nature of the solution asymptotically in terms of possible oscillatory, convergent or divergent behavior and calculate the final value.

Problem 4: Find the time-domain solution for the following differential equation using Laplace transforms:
\[
\frac{d^4 x}{dt^4} + \frac{d^3 x}{dt^3} = \cos t
\]
\[
x(0) = \frac{dx}{dt}(0) = \frac{d^2 x}{dt^2}(0) = 0, \frac{d^3 x}{dt^3}(0) = 1
\]
Before you invert, comment on the qualitative nature of the solution asymptotically in terms of possible oscillatory, convergent or divergent behavior and calculate the final value.