1. **Classification of differential equations:**
   linear, nonlinear, autonomous.

2. **Methods for solving:**
   a. separable ODEs, (Problems: (pp. 35-36): 7, 13, 17, 21, 29, 36)
   b. homogeneous ODEs (Problems: (p. 75) 35, 39 ),
   c. exact ODEs (Problems: (p. 75): 5, 7, 11, 13, 15, 27, 29 ),
   d. linear ODEs (Problems: (p. 55): 5, 13, 15, 21, 22, 23, 24, 27, 37, 39 ).
   e. Bernoulli and Riccati Equations (Problems 22-27, p.55)

3. **Qualitative methods:**
   a. slope field,
   b. finding equilibria, determining stability, plotting phase line (Problems: (p. 100): 7, 8, 9, 11 17, 19, 25, 30 ).

4. **Text problems:**
   a. Second Newton’s Law (Problems: (p. 44): 5, 7, 11 ),
   b. mixing (Problems: (p. 61), 1, 5 ),

**Existence and uniqueness of solutions:**
Theorem on existence and uniqueness of solutions of initial value problems, domain of existence, examples showing nonuniqueness. (Problems: (p. 86): 1, 3, 5, 7, 21, 23, 29, 30, 32)
(a) Find a general solution, a particular solution for a given initial condition, determine the interval of existence, and sketch the plot of the solution:

(a) \( y' = (1 + y^2) x^2, \quad y(0) = 0, \)

(b) \( x^3 y' + 2x^2 y = \sin x, \quad y \left( \frac{\pi}{2} \right) = 0. \)

(b) A rocket is fired vertically and ascends with constant acceleration \( a = 100 \text{m/s}^2 \) for 1 min. At that point, the rocket motor shuts off and the rocket continues to move under the influence of gravity. Find the maximum altitude acquired by the rocket. Ignore the air resistance.

(c) A 100-gal tank originally contains 50 gal of fresh water. At \( t = 0 \), a solution containing 0.3 lb of salt per gallon water begins to flow into the tank at a rate of 3 gal/min and the well stirred mixture flows out of the tank at a rate of 2 gal/min. How much salt is in the tank after at \( t = 10 \) min?

(d) Show that the following equation is exact and find a general solution:

\[
(1 - y \sin x)dx + \cos xdy = 0.
\]

(e) Show that the following equation is homogeneous and reduce it to a separable equation:

\[
y' = \frac{2xy}{x^2 - y^2}.
\]