1. [10 pts.] Solve the nonlinear differential equation:

$$x^2 y'' + (y')^2 = 0$$

2. [10 pts.] The curvature of a curve given by $y = f(x)$ is defined as

$$\kappa = \frac{y''}{[1 + (y')^2]^{3/2}}.$$

Find a function $y = f(x)$ for which $\kappa \equiv 1$. (Constants of integration can be chosen to equal zero to accomplish this most easily.)

3. [15 pts.] A mass weighing 10 pounds stretches a spring 2 feet. The mass is attached to a dashpot device that offers a damping force numerically equal to $\beta > 0$ times the instantaneous velocity. Determine the values of the damping constant $\beta$ so that the subsequent motion is (a) overdamped, (b) critically damped, and (c) underdamped.

4. [15 pts.] Find a power series solution $y = \sum c_n x^n$ for $y' = x^2 y$ by the power series method.

5. [20 pts.] Use the power series method to solve the initial-value problem

$$y'' + xy' - 2y = 0, \quad y(0) = 1, \quad y'(0) = 0.$$