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18.034 Honors Differential Equations
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1. Suppose $y_0(x)$ is a solution to the equation

$$y' + 2xy = f(x)$$

with $y_0(0) = 3$. Find a solution $y_1(x)$ with $y_1(0) = 1$.

2. (Birkhoff-Rota, p. 17, #5) For what pairs of positive integers n, r is the function $f_n(x) = |x|^n$ of class C^r ?
3. Show that the equation

$$(3e^{2y}x^{\frac{2}{3}} - x)y' = 1$$

becomes an equation of Bernoulli type if x and y are interchanged. Solve that equation and obtain an equation for x . Find an explicit formula for $y = y(x)$ for the solution satisfying $y(1) = 0$.

4. Find equations for the family of curves orthogonal to the curves $xy = c$. Do the same for the families $y = ce^{x^2}$.
5. Suppose that y is a solution to

$$(x^2 + 1)y' + y^2 + 1 = 0$$

with $y(0) = c > 0$. Prove that y is decreasing and $\lim_{x \searrow -1/c} y(x) = \infty$.