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18.034 Honors Differential Equations

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1. Logarithmic spiral.

2. (Birkhoff-Rota: p. 6, #6) Show that the functions of $y' = g(y)$, for any continuous function $g(y)$ are either all increasing or decreasing functions in any strip $y_{i-1} < y < y_i$ between successive zeros y_i of g.

3. (Birkhoff-Rota: p. 11, #3) Find all solutions of the ODE $xy' + (1-x)y = 0$, then do the same for the equation $xy' + (1-x)y = 1$.

4. (Birkhoff-Rota: p. 11, #10) Show that the ellipses $5x^2 + 6xy + 5y^2 = C$ are integral curves of the ODE

$$(5x + 3y) + (3x + 5y)y' = 0.$$

   What are its solution curves?

5. Solve $y' + y\cos x = \cos x$ first by the method of integrating factors, and then by the method of variation of parameters.

6. Show that the solution of $2y'' = 3y^2$ with $y(0) = 0$ and $y'(0) = 1$ is given implicitly by

$$\int_0^y \frac{dt}{\sqrt{1+t^3}} = x.$$

   This is an example of an *elliptic integral*.