ODES

non linear	linear
$y^{(3)} + xy' = e^{y}$	**inhomogeneous** $\quad y'' + e^{x}y = \cos x$
	homogeneous $\quad y'' + x^2 y' = 0$ $\quad$ #1,2

ODE's

n^{th} order	1st order
$y'' + xy = 2$	$xy' + e^{x}y = x$
	standard form $\quad y' + \dfrac{e^{x}}{x}y = 1$
	differential form $\quad x\,dx + (e^{x}y - x)\,dy = 0$

1st-order

linear $\qquad$ #7
$$y' + P(x)\,y = f(x)$$

Exact / Inexact $\qquad$ #5,6
$$M(x,y)\,dx + N(x,y)\,dy = 0$$
$$M_y = N_x \quad , \quad (M_y - N_x)/N = f(x)$$

Separable $\qquad$ #3,4
$$y' = h(x)\,g(y)$$

Bernoulli $\qquad$ #8
$$y' + P(x)\,y = f(x)\,y^{n}$$

METHODS.

#1 for polynomial coeffs.
try $\quad y = x^{m}$

#2 for constant coeffs.
try $\quad y = e^{mx}$

$\Big[$ linear homogeneous $\Rightarrow$ family of linear combinations is a solution $\Big]$

#3, #4 separate variables
Integrate both sides, solve for y.

#5 Find $f(x,y)$ the potential. Set $f(x,y) = c$.

#6 Mult. by integrating factor $\mu(x) = e^{\int \frac{M_y - N_x}{N} dx}$

#7 Mult. by integrating factor $\mu(x) = e^{\int P(x)\,dx}$

#8 Substitution
$u = y^{1-n}$, then integrating factor.

Solutions
particular (specific) (IVP)
parameterized family
$\quad c, \, c_1, \, c_2$
Explicit $\quad y = f(x)$.
Implicit $\quad f(x,y) = c$