DiffEq Cheat Sheet

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3.1 Modeling with Linear DE

Radioactive Decay	$x(t)=x_0*e^{(kt)}$
Population	$P(t) = P_0*e^{(kt)}$
Compound Interest	$S(t)=S_0*e^{(rt)}$
Cooling/Heating	$T(t)=T_m+(T_0-T_m)*e^{(kt)}$
Mixing of Two Fluids	$dA/dt=R_{in}-R_{out}$

Examples

Population increases proportional to #people at time t. If initial population P0 has doubled in 7 years, how long will it take to triple/quadruple?
2P0/P0=e^(kt) => ln(2)=kt => k=ln(2)/7 => (ln(2)/7)
t(trip)=ln(3)/[ln(2)/7] = 11.09yr => t(quad)=ln(4)/[ln(2)/7] = 14yr
A tank contains 1000 L pure h2o. Brine w/ 1 kg/L salt pumped in @ 6L/min; the well-mixed solution is pumped out at the same rate. When will concentration = 0.5kg/L
A'(t)=Rin-Rout => Rin=6kg/min; Rout=(A/1000kg/L)*(6L/min)=3A/500 kg/min
A'(t)+3A/500=6 => A(t)=1000+Ce^(-3t/500) => A(0)=0 => C=-1000
1000=1000e$^{(-3t/500)=500 \Rightarrow e}$(-3t/500)=1/2 => t=115.53s