Section 31.6: Applications of First Order DEs

Tuesday, February 6, 2018 11:10 AM

note: we omit 31.5
we omit the electrical circuit applications

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why do we care about solving DEs? because they show up in so many applications!

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example: If a population is allowed to grow unchecked (no predators, no disease, enough habitat and food), then the rate of growth for that population is proportional to the population at that time.

a) Write a differential equation that expresses this relationship. Use P for population.

$$\frac{dP}{dt} \propto P$$

rate of growth

$$\boxed{\frac{dP}{dt} = kP}$$ where k = constant

b) If the initial population is P_0 at $t=0$, find an expression for $P(t)$.

$$\frac{dP}{dt} = kP$$

$$\int \frac{dP}{P} = \int k\,dt$$

$$\ln P = kt + C$$

$$P = e^{kt+C}$$

$$= e^{kt} e^{C}$$ some other constant

$$P = C_1 e^{kt}$$

but at $t=0$, $P = P_0$

$$P_0 = C_1 e^{0} \quad \text{so} \quad C_1 = P_0$$

$$\boxed{P = P_0 e^{kt}}$$