The following written homework problems are due on 9/22 (Wednesday) or 9/23 (Thursday). *You also have a WebWork assignment due two days before the written homework.* ***Tip:*** Not all numbers will be "nice." For some problems, you may need to use WolframAlpha (or other software) for the final calculations.

(2.1) The turkey population in Downtown Minneapolis is getting out of control! Let $P(t)$ represent the turkey population after t weeks. The turkey population satisfies the differential equation

$$\frac{dP}{dt} = (0.5)P^{1.5}.$$

(a) Suppose that there are initially 9 turkeys. Determine the solution to this initial value problem.

(b) Show that there is a number, D (known as the *takeover number*), such that after D weeks, $P(t) \to \infty$. In other words, you want to find D such that $\lim_{t \to D^-} P(t) = \infty$.

(2.2) Your dad makes you another cup of chai. At 10:00 AM, the chai is 98°C. The room is held at a constant temperature of 22°C. When you take your first sip of chai, it is 82°C and the cooling rate is 1°C per minute. What time did you take your first sip?

(2.3) **Professional Problem Skills Practice.** Instead of a full professional problem this week, you are going to practice formatting long computations. We are going to consider the following mixing problem:

The country of Mathland currently has \$60 million in paper currency. Each day, the treasury department will add \$2 million worth of newly designed paper currency and remove \$2 million worth of **all** paper currency (new and old) at the same rate, so that the total amount of currency in circulation is always \$60 million. Then we can model this by $\frac{dy}{dt}$ = [rate in] - [rate out], as in the lecture notes to obtain:

$$\frac{dy}{dt} = 2 - \frac{y}{30}.$$

As we know that Mathland starts with only **old** currency, we have that $y(0) = 0$.

(a) Solve the initial value problem.

(b) How long will it take for the new bills to account for at least half of the currency in circulation?

Instructions: You do not need to write an introduction or re-write the full problem above. However, on the next page is correct scratch work for the problem. Format these computations neatly (and double-check your work, just in case!). You should briefly explain why the constants are changing, and give a brief explanation of a few sentences why the final answer is on the 21st day for part (b).

If you need a refresher on specific professional problem expectations, please read back through the Professional Problem Checklist on Canvas.

$\frac{dy}{dt} = 2 - \frac{y}{30} = \frac{60-y}{30}$ is a separable DE.

Thus $\int \frac{30}{60-y}\,dy = \int dt$

$-30 \cdot \ln|60-y| + C = t + D$

$\ln|60-y| = -\frac{t}{30} + E$

$|60-y| = e^{-t/30+E} = Fe^{-t/30}$

$60-y = Ge^{-t/30}$

Finally $y = He^{-t/30} + 60$ is general sol^n.

Since $t=0$, $y=0$, we can find H:

$0 = 60 - He^0 = 60 - H \Rightarrow H = 60$, so

part. sol^n is $60 - 60e^{-t/30}$

Solve for t if

$30 \geq 60(1 - e^{-t/30})$

$\frac{1}{2} \geq 1 - e^{-t/30}$

$e^{-t/30} \geq 1/2$

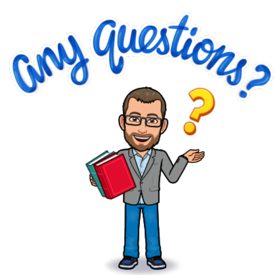
$-t/30 \geq \log(1/2)$

$t \leq 30 \log(2)$

$\Rightarrow 21^{st}$ day

You should have questions! When you do, here's what to do:

1. Post your question on Canvas: http://canvas.umn.edu/
   The answers you get will help everyone in the class!
2. Email *all* of the instructors with your question.
3. Write your solution (even if you're unsure about it) and bring it to the study session. Ask an instructor *specific questions* about it.
4. Start an impromptu study session on Google Chat or similar service!



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