Math 466 Methods of Applied Math III **Firstname Lastname**
HW1: (1) 2.5, (2) 2.6, and (3) MATLAB code for example in book

Introduction
This intro section is not required for your homework file.

- This document doesn't actually show the homework problems. Instead, it replicates Examples 2.1 and 2.3 in the book, as well as shows you how to incorporate MATLAB into your LaTeX file, and in so doing, gives you a template to adapt for your homework.
- The beginning of your homework document should have a header comparable to the one shown at the top of this page. To do this, simply edit the LaTeX code in this template to obtain the header for your assignment.
- The Menu button in Overleaf allows you to make some settings selections. I like to turn off the Auto-complete and Auto-close Brackets options, because for me these seem to introduce unintended commands.
- An internet search will typically answer most of your LaTeX questions.
- Overleaf is a good resources for learning LaTeX, see `https://www.overleaf.com/learn/latex/Main_Page`.
- Directions for working with LaTeX for this assignment are given throughout the LaTeXcode for this template.
- See also the directions given in the HW1 pdf document found on our D2L course page in the Homework folder.

Problems

There are several problems to illustrate in this template, so we will use the LaTeX enumeration field, as can be seen in the commands in the LaTeX file.

1. There are several parts to this first problem, so we will use another LaTeX enumeration field, using the command `\begin{enumerate}[(a)]` to start things off this time.

   (a) Solve the IVP

   $$\frac{dN}{dt} = -kN, \quad N(0) = n_0 \tag{1}$$

   Solution
   Since the differential equation (1) is separable and $N > 0$, we have,

   $$\begin{aligned}
   \frac{dN}{dt} &= -kN \\
   \frac{dN}{N} &= -kdt \\
   \int \frac{dN}{N} &= -k \int dt \\
   \ln(N) &= -kt + C \\
   N(t) &= e^{-kt+C} \\
   N(t) &= e^C e^{-kt} \\
   N(t) &= Ae^{-kt}, \quad A = e^C
   \end{aligned}$$

   Using the initial condition $N(0) = n_0$, we obtain

   $$N(0) = A = n_0$$

   Thus

   $$N(t) = n_0 e^{-kt} \tag{2}$$

(b) Suppose we needed to find the long term behavior of $N(t)$. If there are only a few steps, then we could display them horizontally:

$$\lim_{t\to\infty} N(t) = \lim_{t\to\infty} n_0 e^{-kt} = \lim_{t\to\infty} \frac{n_0}{e^{kt}} = 0.$$

However, it is often better on a homework assignment to display a sequence of steps vertically:

$$\begin{aligned}\lim_{t\to\infty} N(t) &= \lim_{t\to\infty} n_0 e^{-kt} \\ &= \lim_{t\to\infty} \frac{n_0}{e^{kt}} \\ &= 0\end{aligned}$$

Comments on the importance of white space on your page.

- Showing steps vertically makes it easier for the reader to see and follow your steps.
- Showing steps vertically gives the instructor the white space on the page needed to write comments and feedback specific for each step, as needed.
- We are going to start a new page for the next part of the problem, so the work shown doesn't get split across two pages.
- The new page may result in a half page of white space, but this also gives the instructor some space to write comments.

(c) If the half-life is τ, find k in terms of τ.
Solution Using Equation (2), we have

$$\begin{aligned} N(t) &= n_0 e^{-kt} \\ 0.5n_0 &= n_0 e^{-k\tau} \\ 0.5 &= e^{-k\tau} \\ \ln(0.5) &= -k\tau \\ \ln\left(\frac{1}{2}\right) &= -k\tau \\ \ln(1) - \ln(2) &= -k\tau \\ -\ln(2) &= -kt \\ k &= \frac{\ln(2)}{\tau} \end{aligned}$$

Let's give this equation a reference number too:

$$k = \frac{\ln(2)}{\tau} \tag{3}$$

Here are some more comments:

- The first time you compile the document, a reference number may show up as ??, but this usually corrects after compiling twice.
- As mentioned on the previous page, it is important in your homework to use a new page with the `\newpage` command to start a new part of your homework when you near the bottom of a page.
- Also use the new page command when starting a new problem.

2. For this problem, let's include some code from MATLAB. To make this work, you will need to obtain the `mcode.sty` file from our K drive share folder (or Homework folder in our D2L course page) and then use the import icon in your Overleaf project folder to upload the mcode.sty file into your Overleaf project folder.

```
function myplot
t = [0:0.1:1];
f = sin(2*pi*t);
plot(t, f); %plot function
end
```

Next, we type in the command for this script in the way that we would use it in the command window of MATLAB:

$\gg$ myplot

The plot created by this script can be seen in Figure 1. To get this kind of output into your LaTeX file, you will first need to save the MATLAB figure as a jpg file. For this document, the figure was saved as myplot.jpg in the MATLAB directory folder. After that, use the upload icon in your Overleaf project folder to get this image into your current project folder.

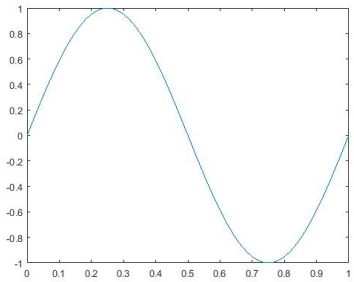

Figure 1: Plot of $\sin(2\pi t)$ on [0,1].

Conclusion
This concludes our template for HW1. Working with LaTeX is like learning a programming language, and gets easier the more you work with it.