Prelab Exercise 3: Transient Conduction

ME 436 Heat Transfer

Introduction

This week, we continue our analysis of conduction; but this time, we remove the always prevalent *'steady-state'* assumption and explore *transient conduction*. In this experiment we will submerge several geometries (and materials) into a heated *bath* and study how the temperature changes with time. We will then compare these observations with two popular models, a *'lumped'* (capacitance) method and a series approximation of the exact analytical solution (for a set of simplistic geometries).

As with past pre-lab assignments, this document will act as a guide towards creating a mathematical model. However, for this lab, the experimental aspects can take considerably more time (30-45min) than before, so it may be wise to split up responsibilities within your group and have some members perform the experiment while others complete this assignment.

Prerequisites

Before attempting this pre-lab assignment, it is imperative that you:

- Complete the pre-lab quiz on Bb.
- Review ***textbook sections 5.1, 5.2, 5.4-5.6***,
- Review ***experiment procedures***, and
- Watch the ***pre-lab videos*** on Blackboard (Bb).

Getting Started

First, if you have not already, you will need to download the starter code from Bb (located in the 'Lab 3' directory) and unzip its contents into the directory where you wish to complete the exercise. Be sure to have completed all of the prerequisites before attempting this assignment.

Files included in this exercise:

Once you have unzipped the contents of the starter package, you should have the following files:

```
 –  ex3.m
 –  /lib
[⋆] ex3_cyl.m
[⋆] ex3_slab.m
[⋆] ex3_sph.m
[⋆] lcm.m
[⋆] one_term.m
```

⋆ indicates files that you will need to complete.

As you can see, there are *three* main scripts in this assignment (one for each shape), in which you will only need to make minor adjustments to these scripts. However, there are *two* functions that will need to be completed.

Environment Setup

Before we can get started, we need to setup our MATLAB environment properly. As always, if using the laboratory computers, be sure to be running your code from the `C:\temp` directory, and also make sure you have unzipped your code properly. Otherwise you may receive '`./lib not found`' errors.

Assignment Outline

To complete this assignment, you will need to do the following:

- Set properties in each **`ex3_<shape>.m`** script.
- Complete **`lcm.m`** & **`one_term.m`**
- Run each script, using your experimental data.
- Complete in-class assignment.

1. Open & Set Properties

To begin open any one of the scripts titled: **`ex3_<shape>.m`**. This will be the main run script for both materials of a given shape. To load data and set the material, you must comment out one of the following lines:

```
%% ================    SETUP    =================

fname = 'brass_cylinder'; matl_type = 'Brass';
%fname = 'steel_cylinder'; matl_type = 'SS';
```

The first line will call an excel sheet titled **`brass_cylinder.xlsx`**, and set the material type to **`Brass`**. Commenting out this line and uncommenting the following will switch to stainless stell.

Now, we arrive to the *properties* section.

To do: *Using information provided in the procedures and definitions in the textbook, fill in the missing information:*

```
% thermal conductivity
kb = 1;  % ???
ks = 1;  % ???

% characteristic length scales
Lc_one_term = 1; % ???
Lc_lcm = 1;  % ???
```

This must be done for each script (shape).

2. Set LCM & One-term approx

Next, open and complete the following functions: `lcm.m` & `one_term.m`. This function requires the calculation of the *Biot* number and the *Fourier* number, before filling in the relation for temperature.

```
% Set Bi / Fo
Bi = 1;  % ???
Fo = 1;  % ???

% Calculate T via LCM (Eq. 5.13)
T = 1;  % ???
```

Once these functions are completed, answer the questions in the in-class assignment.