Lab 2

Ch En 263 – Numerical Tools

Due: 11 Jan. 2024

Instructions

- Complete the exercise(s) below, and submit the following files to Learning Suite:
  - Handwritten portion: scan each page (or take a picture) and combine them into a single pdf named: `LastName_FirstName_Lab2.pdf`
  - Excel portion: submit a workbook named `LastName_FirstName_Lab2.xlsx` where each worksheet tab is named "Problem_1", "Problem_2", etc.
  - Python portion: submit a separate file for each problem named `LastName_FirstName_Lab2_ProblemXX.py` where XX is the problem number.
- Warning: the LS assignment will close promptly at 11:59 pm and late assignments will only receive 50% credit.

Lab Exercises

The rate of heat transfer (q) from a heated flat plate with a cool fluid stream flowing across it can be found by:

$$q = h\Delta T,$$

where h is the heat transfer coefficient and ΔT is the change in temperature between the cool fluid and the plate. The heat transfer is related to Nu, the dimensionless Nusselt number, through

$$\mathrm{Nu} = \frac{hL}{k} = 0.332\,\mathrm{Pr}^{1/3}\,\mathrm{Re}^{1/2},$$

where L is the plate length, k is the fluid's thermal conductivity, Pr is the dimensionless Prandtl number, and Re is the dimensionless Reynolds number. The last two quantities are given by

$$\mathrm{Re} = \frac{\rho L v}{\mu}, \qquad \mathrm{Pr} = \frac{\mu c_p}{k},$$

where μ is the fluid viscosity, c_p is the fluid heat capacity, v is the fluid velocity, and ρ is the fluid density.

1. In an Excel worksheet, find the heat transfer rate in $\mathrm{W/m^2}$ from a flat plate 2 m long and at T=343 K, if a stream of water passes over it at a velocity of 1.45 m/s. The temperature of the water is 294 K. The water properties are $\mu = 9.79 \times 10^{-4}\,\mathrm{Pa \cdot s}$, $\rho = 998\,\mathrm{kg/m^3}$, $k = 0.601$ $\mathrm{W/(m\,K)}$, and $c_p = 4.18 \times 10^3$ $\mathrm{J/(kg\,K)}$. Make sure you present the data so that it is readable.
2. Find the same heat transfer rate using a Python code. Print your answer to the console so that the output looks like:

```
q = #### (W/m^2)
```

Hint: Begin by defining variables for all the known quantities, and then compute Nu. *h can be obtained once* Nu *is known.*