

ENGR 102**Lab: Topic 5 (individual)****Canvas and ZyBook****100%**

This is an individual assignment, use individual header.

Deliverables:

There are two deliverables for this individual assignment. Please submit the following files to **Canvas** and **zyBooks**:

- boiling_curve_planning.pdf
- boiling_curve.py

Activity #1: Planning a program – individual {60%} Submit on Canvas

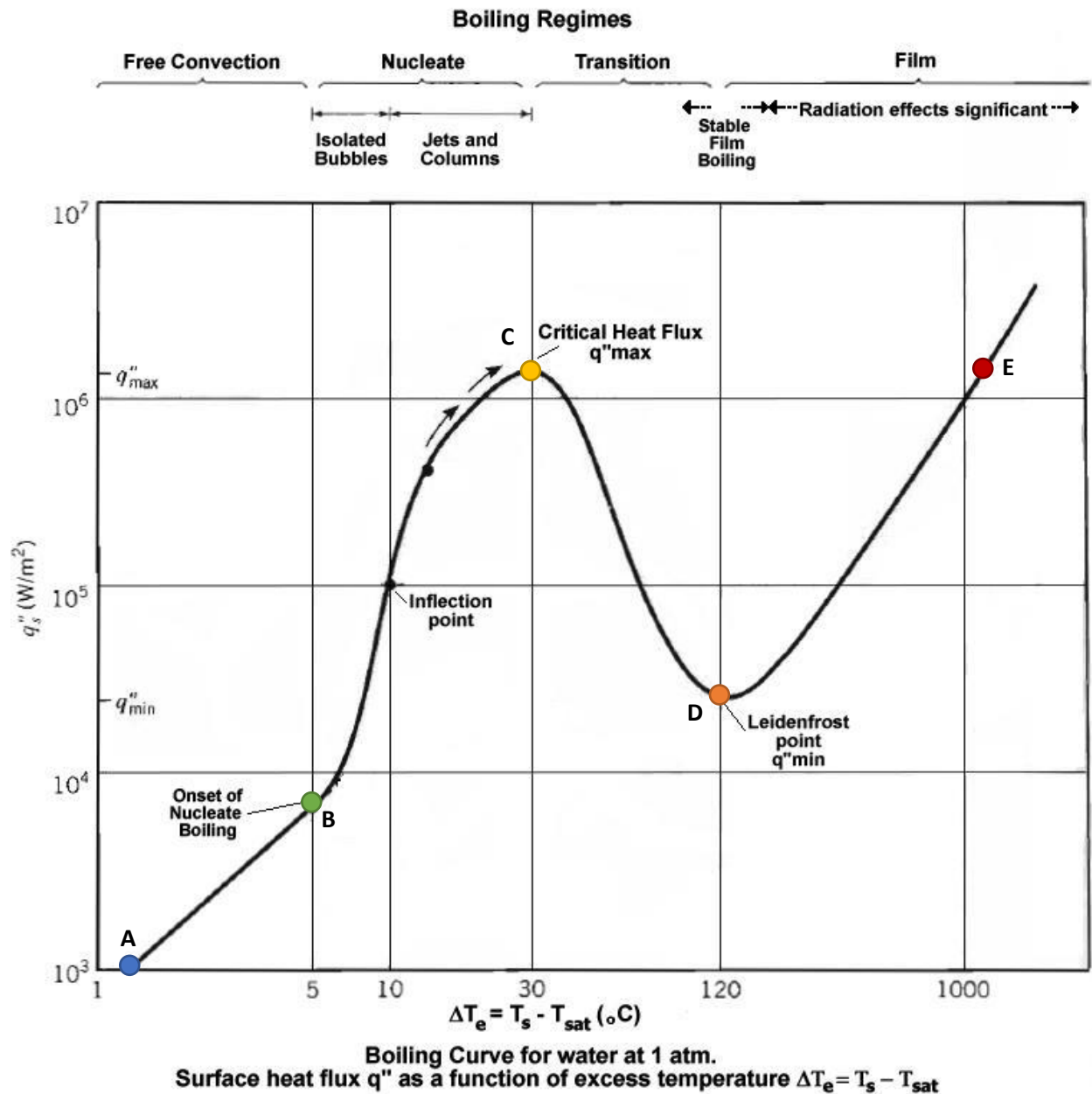
In this individual assignment, you should follow a similar strategy to the one pursued for your team assignment. Note: in comparison to the team program, there are far fewer conditions and necessary test cases. However, there is more computation, including practice interpolating data (remember the topic 2 labs?). You may want to review the process for interpolation posted in Module 2 on Canvas, and see the note below the graph on the next page.

Create a Python program that will calculate the surface heat flux for water at 1 atm for a given excess temperature. You will need to create a simplified model for the relationship between heat flux and excess temperature, based on the graph on the next page (from Wikipedia where you can learn more about boiling: https://en.wikipedia.org/wiki/Nucleate_boiling). The boiling curve is important in several engineering disciplines. It informs us what boiling regime is occurring, which then helps us to determine the heat transfer coefficient, as well as physically what is going on. Different fluids have different boiling curves, however they all have a similar shape.

For this part of the assignment, put together a document you will use to plan your program. You will submit a PDF of this document titled **boiling_curve_planning.pdf**. Do this **before** you start to code.

First, examine the boiling curve. The curve starts out with a linear region for free convection, where boiling has not started (points A to B). The onset of nucleate boiling (B) starts at 5 °C of excess temperature and continues roughly linearly until the critical heat flux (C) is reached. This portion of the curve is the nucleate boiling regime, which is what we typically see when boiling water for cooking pasta. There is a negative roughly linear trend from the critical heat flux down to the Leidenfrost point (D) which is the transition region, followed by an upward nearly linear film region (D to E). You do **NOT** need to understand the physics behind the boiling curve for this assignment.

Come up with a simplified, purely linear model of the stress-strain curve. In other words, approximate the curve by a series of **straight-line segments** between the labeled points. You should approximate the graph using 4 linear segments. The lines should begin at point A and end at point E. Using more lines would give a more accurate representation, but would be more work in coding; for this assignment, you do not need to be precise, and should use just 4 segments along with **the points given below the graph**.



Points: A: (1.3, 1000) B: (5, 7000) C: (30, 1.5×10^6) D: (120, 2.5×10^4) E: (1200, 1.5×10^6)

Note: This graph is a log-log plot (both axes are on a logarithmic scale) so the normal equation for linear interpolation won't work. Instead, use the following equations:

$$y = y_0 \left(\frac{x}{x_0} \right)^m, \quad m = \frac{\log \left(\frac{y_1}{y_0} \right)}{\log \left(\frac{x_1}{x_0} \right)}$$

In python, $\log(x)$ is the natural logarithm and $\log_{10}(x)$ is the base-10 logarithm.

Date: _____

DUE DATE: 10/01/2018

You name _____ Team # (table) _____

You'll now work on taking your linear approximation of the boiling curve, and creating a program that can evaluate it for you (given an excess temperature, calculate and report the surface heat flux).

Next, consider what values you need to store, and the general steps you will need to follow in your program.

- [10] Make a list of the variables you think you will need, and the names you will use.
- [10] Create a sequence of steps that you will follow
 - If you have a conditional statement (you should have a few!), you might want to indicate each part of the condition as a separate action
 - The computation will involve a few stages. Please separate the stages into different parts; do not just say "compute surface heat flux".

Next, create a list of test cases that you will use in your program. Be sure to handle both "typical" and "edge" cases. **Do this before writing the program itself!**

- [20] Similar to the group activity, for each test case provide the input, the expected output, and identify the type of case ("typical" or "edge")
- [10] Note that you should try to come up with a complete set of test cases that thoroughly test the idea (you should have **at least 10** test cases)
- [10] Your program should handle input excess temperatures outside the provided range on the graph by printing a message to the screen

Your PDF should contain your variable list, your sequence of steps, and your test cases.

Activity #2: Boiling curve – individual [40%] submit on ZyBook

AFTER doing Activity #1, construct your program and name the file **boiling_curve.py**. Submit on Zy Book. Your program should ask users for an excess temperature, and report the surface heat flux. As you write your program, please be sure to do the following:

- Remember debug your code before put input from the user part. Then add user input and check if it is working.
- Include comments for your program. It's a good idea to begin by converting your list of steps into comments.
- Develop incrementally. Write some code then test it before writing the next section of code.
- Be sure your program runs and passes all of your test cases. You can submit your code as many times as you want to zyBooks. This is a good way to check your code and see if it passes Dr. Ritchey's test cases.
- Your code should output in the format below, rounding to the nearest integer for the calculated surface heat flux.

Example output (using input: **3**)

Enter the excess temperature: **3**

The surface heat flux is approximately 3347 W/m²

Example output (using input: **-1**)

Enter the excess temperature: **-1**

Surface heat flux is not available