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Creation of Programming-based Problem Bank for Introductory Thermodynamics

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Project Scope

Thermodynamics is an essential topic in many university programs, such as engineering, physics and chemistry. In the Faculty of Applied Sciences, it is offered to students in the materials, mechanical, civil, electrical engineering and manufacturing programs.

The objectives of this project include:

- Use open sources programming languages such as Python and Jupyter to revolutionize the approach to teach thermodynamics.
- Develop a problem bank to accompany Dr. Claire Yan's open textbook published on BCcampus [1] (Figure 1).

Features of the Problem Bank

- A total of 10 questions for each of the six chapters from the e-textbook has been created [2]. The outline of the Problem bank [3] is shown in Figure 2.
- The source code of all questions are openly accessible, permitting students and instructors to experiment with various input parameters for learning and teaching key concepts in thermodynamics.

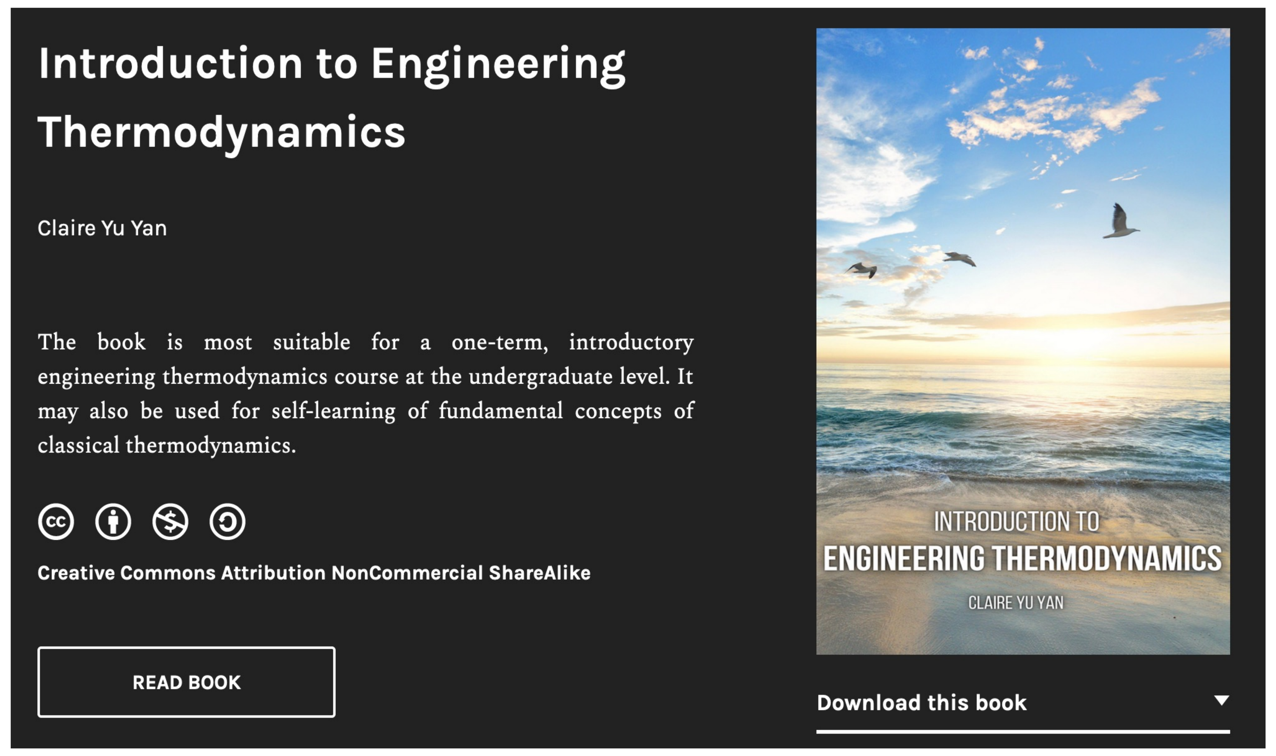

Figure 1: Open textbook Introduction to Engineering Thermodynamics by Dr. Yan

Work in progress

At present, work is being done to show some interactive property diagrams so that students can appreciate the plethora of diagrams that can be drawn for a given fluid.

Figure 4 shows a P-v diagram for Water and Ammonia [4] fluids, a textbox will be added for a (x, y) point to appear on the interactive plot. This will help get students get a visual sense of which state the fluid is in.

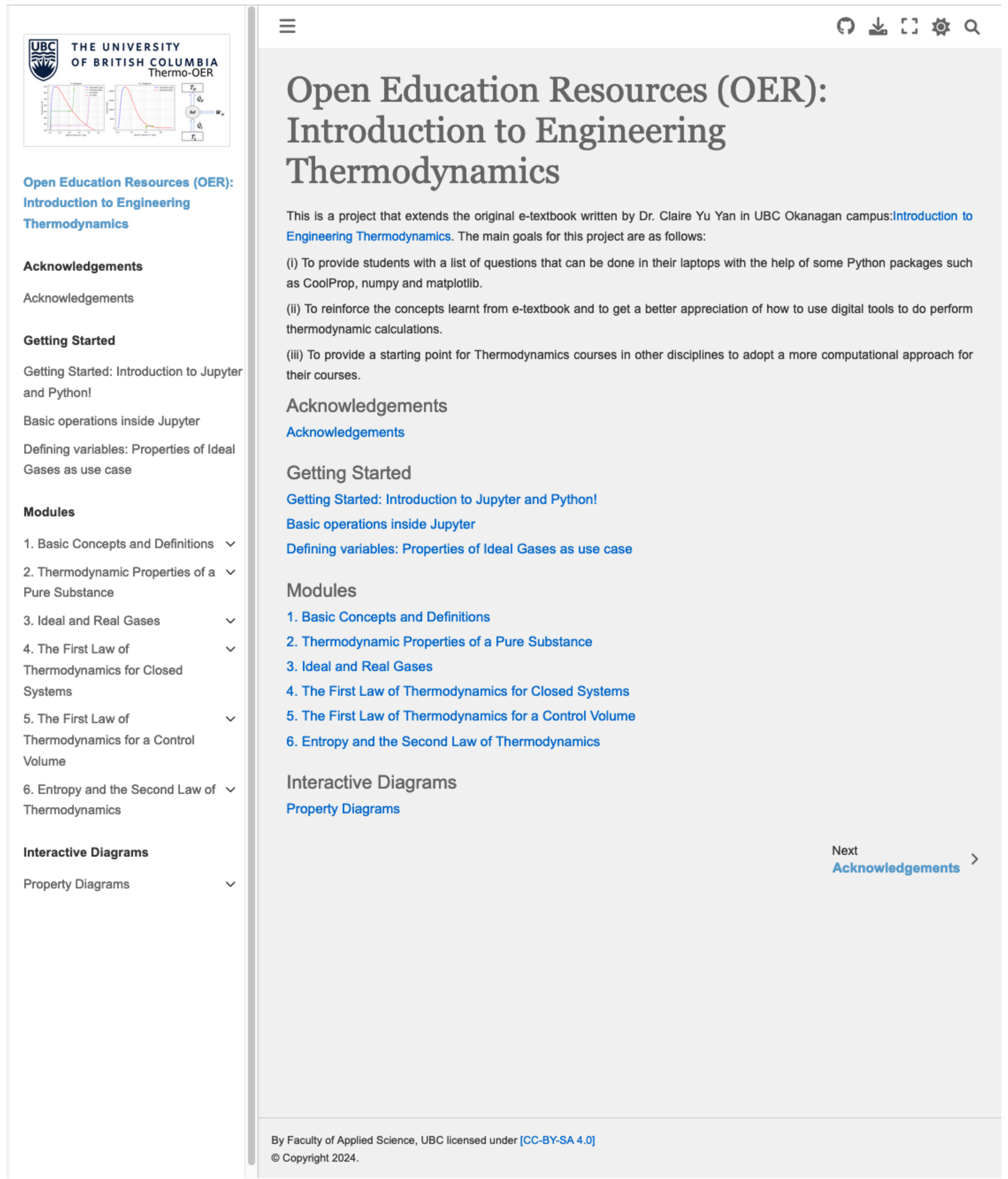

Figure 2: Problem bank website as a Jupyter book found here: Webpage link

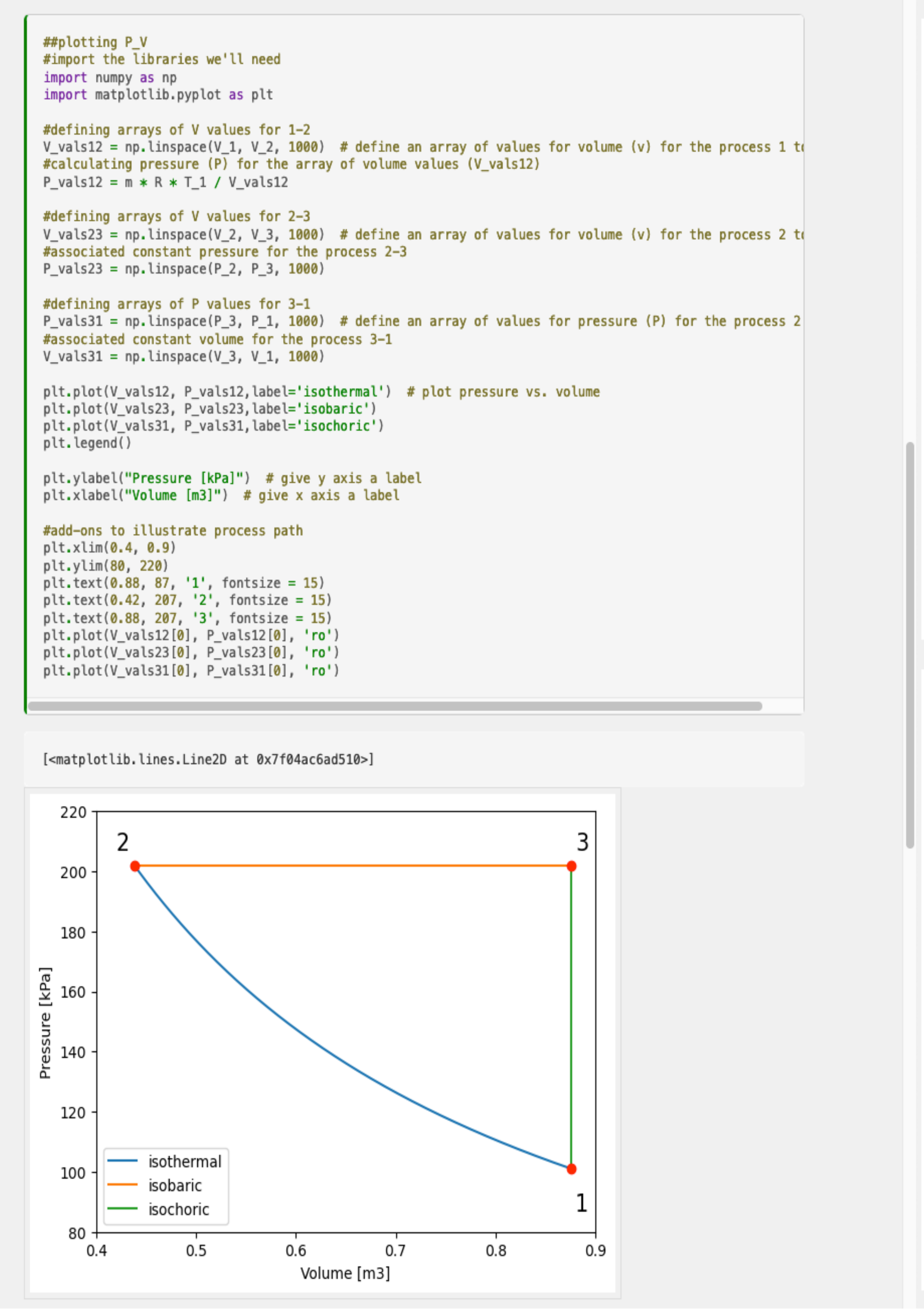

Figure 3: A typical example of working code and a plot to visualize the thermodynamic states

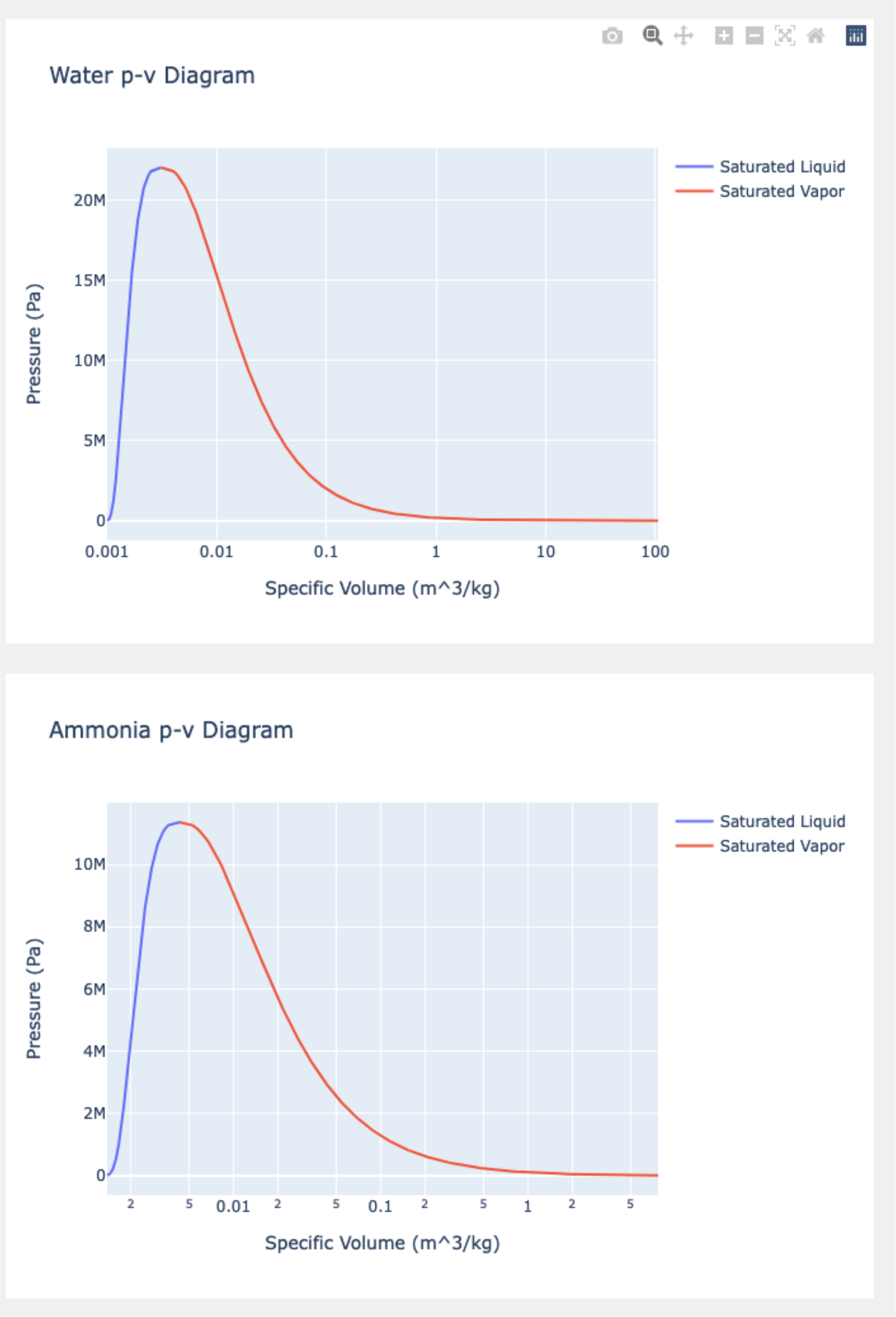

Figure 4: Interactive thermodynamic property diagrams

References

1. Yan, C. Y. (2022). Introduction to Engineering Thermodynamics. Retrieved from here
2. Executable Books Community. (2020). Jupyter Book (v0.10). Zenodo. DOI
3. Open Education Resources (OER): Introduction to Engineering Thermodynamics — OER Engineering Thermodynamics. (2024, February 09). Retrieved from here
4. Bell, I. H., Wronski, J., Quoilin, S., & Lemort, V. (2014). Pure and Pseudo-pure Fluid Thermophysical Property Evaluation and the Open-Source Thermophysical Property Library CoolProp. Ind. Eng. Chem. Res., 53(6), 2498–2508. DOI

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Acknowledgement

We gratefully acknowledge the financial support for this project provided by UBC Vancouver via the OER Affordability Grant.