School of Engineering, Faculty of Applied Science

Developing an Open Textbook: Introductory Thermodynamics

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Project Scope

Thermodynamics is a fundamental subject in many programs, such as engineering, physics and chemistry. In the School of Engineering, it is offered to all engineering students in the mechanical, civil, electrical and manufacturing programs.

This project aims to create an open textbook on introductory engineering thermodynamics, which contains the most fundamental topics of classical thermodynamics suitable for an entry-level undergraduate engineering course and is openly licensed for use by instructors and students.

Benefits to Students and Community

According to the 2019 College Board research, the average annual cost for books and supplies for full-time, undergraduate students at a four-year university is approximately US$1240.[1] The high cost of textbooks can negatively impact students' access to learning materials, selection of courses, and academic performance. [2]

Open education resources (OER) has the benefits of reduced cost, improved accessibility, and better retention rate. [3] This project will bring students a more concise, freely-accessible alternative to commercial textbooks, which helps reduce their financial stress. The benefits to instructors and a broader community are shared knowledge and more adaptive, flexible teaching and learning material for open education.

Book Features

- Six concise chapters tailer-made for the 1st undergraduate thermodynamics course.
  1. Basic concepts and definitions
  2. Thermodynamic properties of a pure substance
  3. Ideal and real gases
  4. The first law of thermodynamics for closed systems
  5. The first law of thermodynamics for open systems
  6. Entropy and the second law of thermodynamics
- Step-by-step solved examples to help students understand key concepts
- User-friendly, pop-out equations and glossary, and alt-text for accessibility (Figure 1)
- Interactive H5P questions for students to perform self-assessment (Figure 2)
- Thermodynamic tables for five common fluids (Figure 3)

Figure 1 Pop-out equations and glossary for accessibility

Saturated liquid-vapour two-phase mixtures	
Quality	$x = \frac{m_g}{m_{mix}}$
Specific volume	$v = v_f + x\,(v_g - v_f) = (1-\ x)\,v_f + xv_g$
Specific internal ene	$u = u_f + x(u_g - u_f) = (1-\ x)u_f + xu_g$
Specific enthalpy	$h = h_f + x(h_g - h_f) = (1-\ x)h_f + xh_g$
Specific entropy	$s = s_f + x(s_g - s_f) = (1-\ x)s_f + xs_g$

Heat engine is such a device that produces wor
from a high-temperature source and reject

A device that produces work continuously by absorbing heat from a high-temperature source and rejecting the waste heat to a low-temperature heat sink.

Publishing Platform

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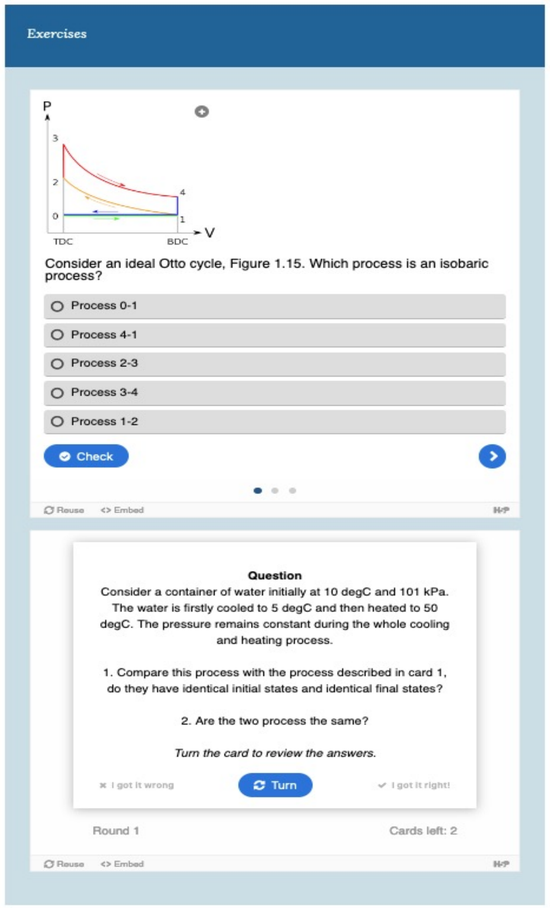
Figure 2 Interactive H5P questions



Work in Progress

Currently, the work is well underway with most part of the book completed. All of the figures, charts and tables are either created by the authors or derived from open repositories. More interactive H5P questions will be added to each chapters, and surveys will be developed to gather student feedback.

Figure 3 Sample thermodynamic tables

Table A1: Saturated Water

T (°C)	P (MPa)	Specific Volume m^3/kg		Specific Internal Energy kJ/kg		Specific Enthalpy kJ/kg		Specific Entropy kJ/kgK	
		v_f	v_g	u_f	u_g	h_f	h_g	s_f	s_g
0.01	0.00061	0.001000	205.991	0.00	2374.90	0.00	2500.92	0.0000	9.1555
5	0.00087	0.001000	147.011	21.02	2381.78	21.02	2510.06	0.0763	9.0248
10	0.00123	0.001000	106.303	42.02	2388.65	42.02	2519.21	0.1511	8.8998
15	0.00171	0.001001	77.8755	62.98	2395.49	62.98	2528.33	0.2245	8.7803
20	0.00234	0.001002	57.7567	83.91	2402.32	83.91	2537.43	0.2965	8.6660
25	0.00317	0.001003	43.3373	104.83	2409.13	104.83	2546.51	0.3672	8.5567

References

1. College Board, *Trends in College Pricing 2019.* https://research.collegeboard.org/media/pdf/trends-college-pricing-2019-full-report.pdf (retrieved on April 19, 2022)
2. Imed Bouchrika, *Average College Textbook Cost: How To Cut It Down Without Compromising Studies.* https://research.com/education/average-college-textbook-cost (retrieved on April 19, 2022)
3. Zhao, Y., Satyanarayana, A., Cooney, C. (2020, November), *Impact of Open Education Resources (OER) on Student Academic Performance and Retention Rates in Undergraduate Engineering Departments,* 2020 Fall ASEE Mid-Atlantic Section Meeting, Virtual (hosted by Stevens Institute of Technology). https://peer.asee.org/36048

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