

Thermodynamics and HVAC Principles and Practice

A Live Workshop on Essential Fundamentals of Thermodynamics and HVAC Principles

Credit: 7.5 PDH's (1-Day); 0.75 CEU's

Instructor: Bobby Rauf, PE, CEM, MBA

Course Number: ST-SEM 106

Course Description

This workshop caters, mainly, to Engineers, Technicians and Facilities Managers who are not intimately familiar with thermodynamics principles and practices. Through this workshop, attendees are expected to learn or refresh fundamental principles and concepts of thermodynamics in a simple, easy to understand, format; catalyzed by live discussion on the topic in class. This workshop/course illustrates application of thermodynamic principles in practical industrial, commercial and residential applications. This course demonstrates how to analyze and solve various types of practical thermodynamic problems through multiple case studies. In this program, laws, equations, graphs, charts, tables and diagrams, pertaining to various thermodynamics concepts, are covered and utilized in the analysis and solution of the case study problems.

Learning Objectives

1. **Understand** the concept of heat energy and its correspondence with work and other forms of energy in the thermodynamics realm.
2. **Understand** the concept of specific heat and its role in calculation of heat associated with change of temperature in thermodynamic systems.
3. **Understand** conversion of energy from fuel form to heat, from heat to steam, from steam to work, and work to electricity – illustrated through a comprehensive, multistage, case study.
4. **Learn** about the concepts of enthalpy, entropy, internal energy, work, and power.
5. **Understand** the difference between sensible and latent heats, and their role in the change of phases of substances.
6. **Gain** understanding about the role of saturated and superheated steam tables in thermodynamics system analysis and determination of the phase of water.
7. **Understand** the practical significance and the difference between various thermodynamic processes, i.e. isobaric, isenthalpic, isentropic, adiabatic, isochoric, isometric, isothermal, etc.

8. **Learn** about Mollier's diagram, the psychrometric chart and their applications in design and optimal operation of HVAC Systems.
9. **Understand** the refrigeration cycle and get insight into refrigeration process through review of pressure-enthalpy performance of DuPont® 134a refrigerant.
10. **Get an appreciation** of energy conservation and process optimization value offered by direct digital, or automated, control of HVAC Systems. Learn about the typical architecture of automated HVAC systems.

Topics:

- Fundamentals for Thermodynamics
 - o Definition, units, and law of conservation of energy
 - o The concept of "system" as it pertains to thermodynamic analysis
 - o Importance of correct assignment of signs to work, and energy of various sorts, including heat energy
 - o Energy conversion and heat calculation case study
 - o Definition and calculation of power in thermodynamic systems
 - o "Steam to Wire" flow of energy and power
 - o Energy unit conversions and associated case study
 - o Enthalpy and entropy
 - o Heat transfer and illustration of entropy calculation through a Case Study
 - o Heat of Fusion, heat of evaporation and heat of sublimation and phases of Water
- Saturated and Superheated Steam Tables
- Class exercise to reinforce understanding and use of steam tables – predicting the phase of water, at given pressure and temperature
- Critical point, triple point and critical properties of water
- Mollier diagram and associated exercise
- Closed and open thermodynamic systems
- First law of thermodynamics
 - o Development and understanding of SFEE, Steady Flow Energy Equation
- Second law of thermodynamics
- Thermodynamic Processes
 - o Adiabatic, isobaric, isochoric, isometric, isentropic, isothermal, throttling, quasi-static, quasi-equilibrium, polytropic, reversible, and irreversible processes
- Topping cycle, bottoming cycle and combined cycle processes
- Turbines
 - o Impulse vs. reaction turbine
- Station Zebra case study
- Psychrometrics and psychrometric chart
 - o Simple vs. comprehensive psychrometric charts
 - o Understanding and application of psychrometric charts
 - o Instrumentation commonly used to acquire psychrometric chart data
 - o Comprehensive psychrometric chart case study

- HVAC and refrigeration cycle
- Automated HVAC system
- Refrigeration cycle case study
 - o DuPont® 134a refrigerant pressure enthalpy graph based analysis

Why you shouldn't miss this course – How this course can benefit your organizations, what is unique about this course:

1. **Does the term thermodynamics sound intimidating** to you? After this workshop, it shouldn't. Your instructor, Professor Rauf will explain those elusive, abstract, and hard to understand thermodynamics concepts, principles and analytical techniques in an easy to understand fashion.
2. How often do you get an opportunity to attend a **workshop or seminar conducted by the author of a text book** on the subject matter? In this workshop, you will have the opportunity to learn from and interact, live, in person, with Bobby Rauf, author of Thermodynamics Made Simple for Energy Engineers. (A copy of the book available at additional cost)
3. Do you manage mechanical engineers, thermodynamics experts, or HVAC engineers, but you are rusty in thermodynamics concepts, analytical techniques and design considerations? This workshop provides you the opportunity to brush up on that knowledge and those skills, so that you can **understand the challenges confronted by your subordinates and colleagues** more clearly, and can make informed objective decisions.
4. Have you ever wondered **how those power generating plants can take water and produce electricity out of it?** Through an illustrative case study, your instructor will show you how to harness electrical power starting with sub-zero ice.
5. If you are unfamiliar with, or are rusty on the **use of psychrometric charts**, and would like to refresh yourself or learn how psychrometric charts are used to analyse HVAC performance and design, then this workshop is a must for you.
6. If you are an engineer who has little or no thermodynamics background, then, this workshop will serve as **an excellent opportunity to cross train** and enhance your knowledge about a subject that your colleagues, around you, might be more familiar with.
7. Are you in a facilities management or maintenance management role? Do you wince every time you confront the high **energy bills associated with the operation of those large chillers and refrigeration machines?** Do you feel perplexed and feel as if you lack sufficient knowledge to understand the **root cause behind expensive repairs associated with those large chillers and refrigeration machines?** Then, this workshop will help you lift the veil of complexity associated with refrigeration cycle

and you will get an opportunity to see through the intricacies of refrigeration cycle through a review of DuPont[®] 134a pressure-enthalpy graph.

8. Remember those **saturated and superheated steam tables**? Perhaps you were never introduced to them? Not to worry. By the end of this workshop, you will gain appreciation for the role of steam tables in assessing the transformation of phases and the conversion of heat energy into work and power.
9. Last, but not least – If you are **not** a licensed Professional Engineer, but aspire to be one, and if you are rusty in the fundamentals of thermodynamics concepts and principles, then this two (2) day course could serve as a **“warm-up”** on some of the thermodynamics mechanical engineering principles, concepts and problem analyses techniques.

Who should attend:

- **Licensed Professional Engineers**, who need to meet the annual or biennial license renewal PDH (Professional Development Hour) or CEU (Continuing Education Units) requirements.
- **Engineers** who are not familiar with the principles of thermodynamics and HVAC
- **Facility Managers, Engineering Managers, Program/Project Managers and other executives** or leaders who feel a lack of adequate thermodynamics and HVAC knowledge to hold meaningful discussions and to make informed decisions in their interactions with their mechanical engineer direct reports or colleagues.
- **Non-engineers**, including **technical writers** responsible for developing operations and maintenance manuals for thermodynamic or HVAC systems.
- **Procurement/purchasing professionals** who are responsible for acquisition of thermodynamic or HVAC equipment.
- Candidates aspiring to take the **FE or PE exams**.
- **Energy Managers or Energy Professionals**
- **Maintenance Engineers and Maintenance Managers**
- **Other professionals** whose annual **PLP, Performance and Learning Program**, includes engineering/technical courses/seminars/workshops.

Instructor Bio:

S. Bobby Rauf, P.E, C.E.M, MBA; Member, ASEE, American Society of Engineering Education.

Mr. Rauf, was inducted as **“Legend in Energy”** by Association of Energy Engineers, in 2014.



Professor Bobby Rauf is the President, Chief Consultant and a Senior Instructor at Sem-Train, LLC. Bobby has over 25 years of experience in teaching undergraduate and post graduate Engineering, Math, Business Administration and MBA courses, seminars and workshops. Professor Rauf is registered (PE) **Professional Engineer**, in the State of North Carolina and is a **Certified Energy Manager**.

Mr. Rauf was inducted as “**Legend in Energy**” by AEE, in 2014. He is a published author of multiple engineering and energy books and professional development courses. He holds a patent in process controls technology.

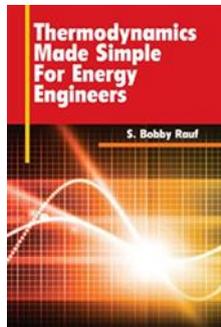
Mr. Rauf develops and instructs PDH (Professional Development Hour) and, continuing education, engineering skill building courses. He conducts these course in form of webinars, live on-site presentations, workshops, pre-recorded audio and self-study texts. Some his major clients include **Texas A&M University, Saudi Aramco – KSA, University of North Carolina at Charlotte, McNeese University, Lamar University, Clemson University, Association of Energy Engineers, EPIC College - Canada; US Bureau of Reclamation, BHP Billiton, PDH Engineers, CED, and PDH Source**. He is also an Adjunct Professor at Gardner-Webb University.

Professor Rauf has also developed and published several self-study books that cater to the continuous professional development needs of Engineers, Technicians and Technical Managers.

Mr. Rauf’s last full-time engineering employment, in the corporate world, was at PPG Industries, Inc. where he served as a **Senior Staff Engineer**. During his long career at PPG, his responsibilities included development and management of energy and ergonomics programs for multiple manufacturing plants, in the US and overseas. He also provided consultation and training services in, energy, electrical engineering, industrial safety, ergonomics and arc flash arena. His extensive engineering experience includes, power design, control system design, project management, process management, energy and utilities management, energy audits/assessments, plant maintenance, robotics, manufacturing automation, HVAC audits, and design of ergonomic equipment.

Professor Rauf has published multiple engineering and energy related books (Available through AEE, Amazon.com, and Barnes and Noble):

- 1) Text book titled **“Thermodynamics Made Simple for Energy Engineers,”** Published in 2012 through Fairmont Press and CRC Press – Worldwide distribution.



- 2) Text book titled **“Electrical Engineering for Non-Electrical Engineering,”** The Second Edition of this book was published in 2016 through Fairmont Press and CRC Press – Worldwide distribution.
- 3) Text book titled **“Finance and Accounting for Energy Engineers,”** Published in 2011 through Fairmont Press and CRC Press – Worldwide distribution.

Mr. Rauf of Sem-Train has provided training services to and instructed at the following organizations over the last fifteen years:

1. BHP Billiton
2. Saudi Aramco (Dammam, Kingdom of Saudi Arabia)
3. US Bureau of Reclamation (Hoover Dam)
4. CED
5. Balfour Beatty
6. Shaw Group
7. N.C. State University
8. McNeese University
9. University of North Carolina, Charlotte
10. Texas A&M University,
11. Clemson University,
12. PPG Industries, Inc.,
13. PDHengineer,
14. PPI,
15. University of Maryland Baltimore County,
16. EPIC (Canada)
17. YF Asia

“SemTrain, LLC, is an approved sponsor and course provider with NCBELS, North Carolina Board of Examiners for Engineers and FBPE, Florida Board of Professional

Engineers, and New Jersey for the provision of CPC, Continuing Professional Competency, courses.”

“SemTrain, LLC, is approved for US Federal Government Contract Work, and is SAM and CAGE registered.

Testimonials from clients:

- 1) Kimberly T., 2011: Bobby, I would like to say that even though I am not an engineer, I am really glad that I took this class. You have helped me to dissect and visualize some of the terms and concepts that were not tangible to me prior to this class.
- 2) J.L. “Jim” S. PE, CMRP, Manager Engineering: “....Bobby is an outstanding instructor and the material was very well presented.....We will want to do this again next year...
- 3) Gregory (Greg) V. D. P.E.: “Hi Bobby, I've enjoyed both of your pdhengineer.com webinars that I've attended.....I don't know how you get through a full 8 hours at such a high energy level!”

Important Notes for Participants:

- In order to enhance the learning experience, the class size is limited – register early.
- Seminars are subject to cancellation if the minimum registration threshold is not met. **Registration fees will be refunded in entirety if a seminar is cancelled.**
- Name on the attendance certificate will be as it appears on the registration documents. **Please Note:** If an admin associate registers you, have them enter **YOUR** name on the registration/payment form.
- Verify exact location of venue before the seminar date. *
- Bring valid ID and copy of registration information. *
- Light refreshments will be served. *
- Certificates of attendance will be provided.
- The handouts for the course will be provided via “Drop Box.”
- Venue Wi-Fi where available. *

** This information applies to in-person, face to face, seminars only.*

Cancellation Policy: Full refund granted if registration is cancelled **30 days** or more prior to the scheduled date of the seminar; otherwise, registrant can apply the course credit toward attendance at another, scheduled, equivalent event, in the region, at a later date.

SemTrain, LLC, reserves the right to cancel the seminar when minimum registration threshold is not met. In such case, SemTrain, LLC, will issue full refund to the registrant.

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