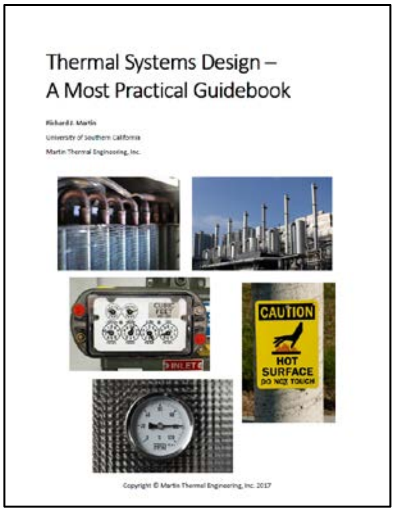
AME-430 Thermal Systems Design (28772, 29072)

Term: Fall 2017 Units: 3.0

Course Syllabus (Rev 0)



Lecture: Th 14:00-16:50
Location: OHE 100C
Discussion (optional): none

Instructor: Dr. Rick Martin

Office: tbd

Office Hours:

RM Th 09:30AM-12:30PM (or by appointment)

Contact Info:

RM richarjm@usc.edu (urgent : rmartin@martinthermal.com)

Teaching Assistant(s): None

Catalog Description Design methodology for thermal systems; boilers, condensers, air conditioning, power generation, air pollution control, combustion and alternative fuels. Prerequisite: AME 331; recommended preparation: AME 312.

Instructors' Description Following a brief review of thermodynamics, fluid mechanics and heat transfer, plus a brief introduction to combustion, students will engage in a step-by-step design effort for one of three projects (wood-waste fueled lumber kiln; landfill gas combustion turbine; earth-coupled heat pump). The goal is to produce a Process Design Package, including: Heat and Material Balance, Process Flow Diagram, Piping & Instrumentation Diagram, and Equipment Data Sheets.

Recommended Preparation The course material presented assumes the student has attained competency in calculus, physics, chemistry, engineering thermodynamics, fluid mechanics, and heat transfer. The format will be lectures plus required design team meetings. There is no lab.

Prerequisite(s): AME 331 **Co-Requisite (s):** none **Concurrent Enrollment:** none

Required Textbook

Thermal Systems Design – A Most Practical Guidebook; by R. Martin (2017). REQUIRED (students pay for manuscript copying costs). ISBN: (none)

Course Notes

Homework: A total of 11 homework assignments will be given (see schedule below). Each homework assignment is worth 50 points. Homework is submitted electronicall on D2L and is due 5 PM on the Friday after the Thursday Lecture due date, listed in the course schedule. Students are responsible for ensuring their homework papers are submitted electronically via D2L. Emails of homework are not permissible. Homework submitted past the deadline is docked 30% - no exceptions.

Design Deliverables: Each **team** will receive a "Request for Proposal" from their "client" that sets forth the scope of work the design team is expected to deliver. Each **student** is individually responsible for "DRAFT" versions of the PFD and P&ID drawings (points included in homework assignment totals above). Time will often be available at the end of class for groups to work on their designs together, and to interact with the instructor if they have questions. Instructor will require teams to provide verbal progress reports at the end of most lectures.

Final Presentation AND Design Package: Each group will have an opportunity to communicate their thermal system design to their classmates with an oral presentation and design package, worth 250 points per student. Each team member is required to deliver a portion of the group's final presentation to the class and respond to questions from students and the instructor. The presentation should include content that focuses on (a) unique aspects of the design, (b) energy cost savings for the customer, and (c) benefits to the environment or local economy. Individual scores will be based in part on the group's work product and in part on the student's individual contribution to the design package and presentation.

Final Exam: A final exam, worth 200 points, will be given on the scheduled date. The exam will cover all subjects covered in the lectures and assigned reading. The exam will focus on concepts rather than calculations, although modest analysis will be necessary to answer some of the questions.

Grading: Students earn points (1000 possible) by successfully completing the following assignments:

- Homework 550 (fewer than 1 per week, graded)
- Design Project 250 (individual and group submission and presentation)
- Final Exam 200 (given on scheduled date for final exam)

Final course grades are based on absolute scores and calibrated against a normal distribution to ensure fairest treatment for each student. See course schedule for reading and homework assignments.

A (920+), A- (880+)	(mastered essentially all the material)
B+ (850+), B (820+), B- (780+)	(mastered the majority of the material)
C+ (750+), C (720+), C- (680+)	(understood a moderate amount of the material)
D (600+)	(only grasped minimum content; consider re-taking course)
F (599 and below)	(failed to grasp the material; must re-take course)

Software Resources: The final exam is open-book, open-notes but closed-smartphone and closed-laptop. Students are expected to bring and use a hand calculator for the exam and bring their own copy of the textbook. Accessing computers/internet is not allowed during any quiz or exam. The group project will require design calculations that are best performed using a mathematical software application (e.g, EES, Matlab, Mathcad, or Excel) to obtain intermediate and final solutions. Some homework assignments may benefit from the use of these same software applications as well. Students are expected to provide their own software and submit printouts with their HW assignment(s).

Learning Objectives

After completing this course, students will be able to:

1. Select a suitable diameter for a pipe or duct for given length and flow.
2. Select a suitable blower or pump to overcome friction pressure drop for a given pipe or duct flow.
3. Prepare a Heat and Material Balance table.
4. Utilize a commercial CAD program to convey process information in a Piping & Instrument Diagram.
5. Estimate adiabatic combustion temperature using JANAF Tables or equilibrium software package.
6. Determine design parameters (e.g., size, temperature) for a thermal oxidizer.
7. Determine design parameters for a shell-tube heat exchanger.
8. Determine design parameters for a Brayton Cycle turbine power generation system.
9. Determine design parameters for an air-coupled heat-pump system.
10. Determine design parameters for a waste heat recovery boiler.
11. Select instruments and final control elements to perform process control and safety control.
12. Select refractory and/or insulation materials to line hot and cold vessels and pipes.
13. Understand concepts such as “deviation”, “likelihood”, “severity” in a Process Hazard Analysis.

Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* http://equity.usc.edu or to the *Department of Public Safety* http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage http://sarc.usc.edu describes reporting options and other resources.

Support Systems

A number of USC’s schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* *http://emergency.usc.edu* will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.

WEEK NO.	DATE	SUBJECT	ASSIGNED READING (Text - Thermal Systems Design)	WORK PRODUCT DUE	HW Assignment (due Friday after lecture)	POINTS
1	8-24	Thermodynamics Fundamentals	Chapter 1 - Thermodynamics	<None>	<Lecture Only>	
2	8-31	Fluid Flow Fundamentals	Chapter 2 - Fluid Mechanics	Homework #1 - Thermo	**tbd**	50
3	9-7	Heat Transfer Fundamentals	Chapter 3 - Heat Transfer	Homework #2 - Fluids	**tbd**	50
4	9-14	Combustion Fundamentals	Chapter 4 - Intro to Combustion	Homework #3 - Heat Transfer	**tbd**	50
5	9-21	Heat and Material Balance, PFD, Customer RFP	Chapter 5 - Process Flow Diagrams	Homework #4 - Combustion	**tbd**	50
6	9-28	Compressors, Blowers, Pumps	Chapter 6 - Thermodynamic Design of Equipment Chapter 7 - Duct, Pipe Network Design	<None>		
7	10-5	Recuperators , Burners, VOC Destruction, ThermOx, Insulation	Chapter 8 - Heat Exchanger Design Chapter 9 - Refractory, Thermal Insulation	Homework #5 - Resistance to Flow	**INDIVIDUAL STUDENT - Draft PFD Schematic, HMB with Tags only**	50
8	10-12	Boilers	Chapter 10 - Boilers	Homework #6 - DRAFT PFD	**tbd**	50
9	10-19	Combustion Turbines	Chapter 11 - Combustion Turbines	Homework #7 - Boilers	**tbd**	50
10	10-26	Refrigeration Systems; Transient Heat Flow	Chapter 12 - Refrigeration	Homework #8 - Brayton Cycle	**tbd**	50
11	11-2	Instrumentation, P&ID, Equipment Specs	Chapter 13 - Piping & Instrumentation Diagram	Homework #9 - Refrigeration Systems	**tbd**	50
12	11-9	Valves, Actuators, Process Control, Safety Control	Chapter 14 - Control of Thermal Systems	Homework #10 - DRAFT P&ID	**INDIVIDUAL STUDENT - Draft P&ID Schematic, Control Loops**	50
13	11-16	Process Hazard Assessment, Product Quality, O&M Manual	Chapter 15 - Process Safety Chapter 16 - Process Quality Chapter 17 - Design for Construction, Operation, Maintenance	Homework #11 - Process Control	**tbd**	50
14	11-23	THANKSGIVING BREAK				
15	11-30	Project Presentations	<none>	Group Presentations	**GROUP - Oral Presentation all Team Members talk; Submit PPT, Design Pkg**	250
FINAL	12-7	Final Exam	Thursday 2 to 4 PM	Final Exam	**INDIVIDUAL STUDENT - Exam**	200
				TOTAL POINTS		**1000**