

Mechanical Engineering and Mechanics

MEM 440 Thermal Systems Design

Winter 2007/Summer 2007

Designation: Technical Semi-elective

Catalog Description: Fundamentals of thermal systems; role of design in engineering practice; economic analysis of thermal systems. Advanced concepts and analysis of selected heat and mass transfer problems; heat exchangers, distillation equipment. Modeling of thermal equipment and thermal systems. Simulation of thermal systems. Fundamentals of optimization; design of optimized thermal systems

Prerequisites: MEM 345 Heat Transfer; MEM220 Basic Fluid Mechanics

Textbook(s) and other required material:

Required: Design of Fluid Thermal Systems
William S. Janna, Thomson Learning, ISBN: 0-53-495319-0

Reference: "Design of Thermal Systems", W.F. Stoecker, third edition, ISBN 0-07-061620-5

Course Objectives: With the growth and omni-presence of thermal systems, such as those related to materials processing, energy conversion, pollution-control, aerospace, and automobiles, the need to design and optimize thermal systems has also grown. The goal of the course is to present a systematic approach to the design and optimization of such systems. Specific objectives are:

1. An understanding of fundamental design principles, role of design in the engineering practice.
2. An understanding of concepts and analysis of specific thermal systems (heat exchangers, pumps, compressors, etc.), mathematical modeling of thermal equipment and systems.
3. An understanding of simulation and its role in engineering design; simulation of thermal systems.
4. An understanding of engineering economics, economic analysis of thermal systems.
5. An understanding of optimization theory; basic optimization procedures; design of optimized thermal systems.

Topics:

1. Design of thermal systems
2. Heat exchangers
3. Mathematical modeling of thermal systems

4. Simulation
5. Economic analysis
6. Optimization
7. Calculus methods: Lagrange multipliers, search methods, other methods

Class Schedule: 3 hours/week lecture (3 credits)

Contribution to Professional Component:

Contributes toward the 1 ½ year of engineering topics appropriate to developing the ability to work in the thermal systems area. Prepares students for carrying out engineering design.

Relationship to Program Outcomes:

0 = No content; 1 = Some content; 2 = Significant content

Outcomes a - k	Content	Explanation	Evidence*
a. An ability to apply knowledge of mathematics, science and engineering	2	The students learn how to apply and synthesize their knowledge of mathematics, science, and engineering in designing thermal systems.	Homework, Quizzes and Examinations, Design Project
b. An ability to design and conduct experiments as well as to analyze and interpret data	2	The design optimization problems require the students to use simulation tools to generate data for the system and analysis.	Final report for the design project; homework problems on system simulation (HW set #5)
c. An ability to design a system, component or process to meet desired needs	2	The assigned thermal system design problems are always required to meet societal or industrial needs.	Final report for the design project and homework problems (HW set #1)
d. An ability to function on multidisciplinary teams	1	Requires knowledge of the thermal-fluids area as well as the knowledge of optimization theory and engineering economics	Final design report
e. An ability to identify, formulate and solve engineering problems	2	The design problems train the students to formulate and solve engineering problems.	Homework, exams, design project
f. An understanding of professional and ethical responsibility	1	This is emphasized as part of the design engineer's overall responsibility.	Classroom discussion of environmental issues; Final report for the design project
g. An ability to communicate effectively	2	Oral presentation of the final design problem is often required.	Final report for the design project
h. The broad education necessary to understand the impact of engineering solutions in a global/societal context	1	The impact of engineering design on the environment (pollution, greenhouse effect, etc.) and society are covered.	Classroom discussion of environmental issues; Final report for the design project
i. A recognition of the need for and an ability to engage in lifelong learning	1	Improvements in thermal systems design come from innovations and advanced technology. Need for lifelong learning is recognized.	Classroom discussion, hand-outs (Fibonacci number series document)
j. A knowledge of contemporary issues	2	Design of thermal systems is related to contemporary issues (global warming, global fuel supply etc.).	Class hand-outs (Clean Energy from the Earth, DoE document)
k. An ability to use the techniques, skills and modern engineering tools necessary for engineering practice	2	Students use MATLAB, EXCEL and optimization packages to simulate physical problems and obtain optimized solutions.	Homework; Final report for the design project