Syllabus

MEMS 1052 (312124030-01) – Thermal Systems Design

Fall Semester 2025

Lecture Time:	Thu. 13:50 – 16:25	**Classroom:**	SCUPI New Bldg. S204
Instructor:	Dr. John Pien	**Office:**	SCUPI New Bldg. N503
Office Hours:	Thu. 08:30 – 11:30 Thu. 16:30 – 17:30 Fri. 08:30 – 12:00	**Email:**	john.pien@scupi.cn

Course Description

In this course, we will combine the three subjects of fluid mechanics, heat transfer, and thermodynamics to study the design of thermal systems. These principles are applied using a system perspective to analyze and understand how interactions between components, such as pump, piping, heat exchanger, and those in the thermodynamic power generation cycles, would affect the performance of the entire system. We will begin with system design concepts and economic analysis, then review the mathematical modeling techniques for the components, then proceed with system simulation methods for finding the operating point of the thermal systems, and conclude with the design of thermal systems through methods of optimization. At the end of this course, students will not only be able to learn how to design and analyze the system but explore optimization opportunities on design improvements to optimize, for example, minimizing the energy consumption or operating costs.

Prerequisites: *PHYS 0174, ENGR 0145, MATH 0290*.

Required Textbook

- No required textbooks are assigned. Relevant reading materials will be provided electronically and posted in BB. Lectures and handouts are all complementary, and necessary for understanding the course materials.
- The textbooks used in SCUPI classes on the topics of heat transfer, fluid mechanics, and thermodynamics are very helpful, and they are referenced frequently throughout this semester. We will, however, review some of the materials, from these classes, for the readiness and enrichment of learning experience.

Referenced Books

Stoecker, *Design of Thermal Systems*, McGraw-Hill.
Jaluria, *Design and Optimization of Thermal Systems*, McGraw-Hill.
Majumdar, *Design of Thermal Energy Systems*, Wiley.
Bejan, Tsatsaronis and Moran, *Thermal Design and Optimization*, Wiley.

Course Objectives

- To understand engineering design process and to define design objectives and understand the basis and criteria for the design of thermal systems.
- To state the requirements of a design problem and show workable solutions that meet the requirements.
- To model thermal system components by integrating principles of thermodynamics, fluid mechanics and heat transfer and using curve fits of tabulated or experimental data.
- To introduce economics into thermal systems analysis and design.
- To combine models of various thermal system components to simulate the performance of a complete thermal system.
- To apply optimization tools to a thermal system to find the best set of operating or design parameters.

Course Outline

- General Introduction
- Basics in Design
- Economic Analysis
- Mathematical Background
- Modeling Thermal Equipment
- Simulation of Thermal Systems
- Optimization of Thermal Systems

Applicable ABET Student Outcomes

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Course Schedule

Week	Date	Topics
1	09/11	Introduction

2	09/18	Basics in Design
3	09/25	Economic Analysis
4	10/02	Holiday
5	10/09	Mathematical Background
6	10/16	Modeling - Review of Fluid Mechanics and Heat Transfer
7	10/23	Modeling - Heat Exchanger
8	10/30	Modeling - Heat Exchanger
9	11/08	Midterm Exam
10	11/13	Modeling - Pumping System
11	11/20	Modeling - Review of Thermodynamics
12	11/27	Modeling - Power Cycles
13	12/04	Modeling - Power Cycles
14	12/11	System Simulation
15	12/18	Optimization
16	12/24	Final Exam
17	01/01	Holiday

Course Outline

- General Introduction
- Basics in Design
- Economic Analysis
- Mathematical Background
- Modeling Thermal Equipment
- Thermal System Simulation
- Thermal System Optimization

Exam Schedule

Midterm Exam	14:00 – 16:00, Sat., Nov. 8th (week 9)
Final Exam	14:00 – 16:00, Thu., Dec. 24th (week 16)

Course Grading

Attendance/Quiz	10%
Homework	15%
Projects	25%
Midterm Exam	25%
Final Exam	25%

Course Policies

Regular class attendance is essential and expected. Active participation in course activities is encouraged which would generally involve focused thinking as well as engaging with instructor and fellow students. Professional classroom demeanor is required; in particular, all cell phones and personal electronic devices must remain off or silent during the lecture. Do not conduct side conversations during the lecture as it is distracting to the lecturer and other students.

Homework Assignments

- Homework problems are assigned periodically and are due as stated in the assigned paper. All work should be submitted electronically through the Blackboard system. It is students' duty to make sure that submission through Blackboard has been properly processed. All homework scores will be used in your grade computation.
- Late submission WILL NOT be accepted. Exceptions will be made for a valid excuse consistent with University Policy. If you have a compelling emergency that prevents you from turning in the homework on time, please email the instructor to get the approval for late submission.
- Unless otherwise indicated, you can work with your fellow classmates, but you must submit a distinct and independent write-up to receive credit. If plagiarism is caught, the homework will receive a zero score.
- All work must be shown for each solution to receive full credit and present your solution in a logical fashion while showing and explaining all important steps in detail.
- If you believe an error has been made in the grading of an assignment, bring it to the attention of the instructor or TA within one week after the graded materials have been made available to the student.

Exams

- There will be two exams (one midterms and one final), all are closed-book and closed-notes. Essential equations will be provided to students during the exams to help answer exam problems. Exams will emphasize treatment of materials covered in lectures and homework assignments.
- If you cannot attend an exam due to emergencies and health issues, you MUST get the approval from the instructor to make alternative arrangements, consistent with University Policy, before the exam is given. If you miss an exam without prior approval, you will receive a score of "ZERO" for that exam except under extenuating circumstances.
- If you believe an error has been made in the grading of an exam, bring it to the attention of the instructor or TA within one week after the graded materials have been made available to the student.

Make-Up Exam

Students who have not taken either the midterm or the final exam are NOT eligible to take the make-up exam. The make-up exam grading is only to replace students' semester final exam grading. Students who pass the course after the make-up exam will receive only a passing grade (60) as the final grade.

Projects

Group design projects will be assigned for the design, analysis, simulation and optimization of thermal, fluid and energy systems. For the group projects, you may work in a group of up to four people (to be assigned).

Evaluation Policy

Partial credit will be awarded to recognize that some portion of the work is correct. However, partial credit grading is only practical if the work is clearly developed, with clear and well-marked diagrams when fitting, with the appropriate equations prominently displayed, where the substitutions into the equations are quite clear, and the assumptions used are obvious to the grader. That is, it is the student's responsibility to present her/his work so clearly that the grader can quickly ascertain the location and nature of the error(s) and can follow the subsequent work through. If this is not clear on the work submitted, credit cannot be given. Partial credit is assigned at the discretion of the grader. It is therefore always in your best interest to practice clarity and completeness in your solutions when working on exam and homework problems.

Copyrights

Academic Integrity

All students are expected to adhere to the standards of academic honesty. Any student engaged in cheating, plagiarism, or other acts of academic dishonesty would be subject to disciplinary action. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include but is not limited to the confiscation of the examination of any individual suspected of violating the University Policy.

Remarks

- Modifications to this syllabus may occur. Please stay informed about any revisions announced during class or on the Blackboard website. Lecture materials, homework assignments, homework solutions and class announcements will also be accessible through Blackboard.
- Important dates and information will be announced during class. Students should stay informed about announcements on Blackboard. While emailing the instructor or TA, please kindly include "Thermal Systems Design" in the subject line for an efficient communication. Please use your university email account (student_ID_number@stu.scu.edu.cn), as emails from other sources could be caught by the SCU spam filter.