

# Mechanical Engineering and Mechanics

## MEM 414 HVAC Equipment

Winter 2007

**Designation:** Elective

**Catalog Description:** Models and analysis of different psychrometric processes; different types of secondary systems (all-water, air-water and all-air systems): description, operating principles, modeling, simulation and sizing; single-stage and multistage refrigeration cycles; vapor compression components (compressor, expansion devices, condensers and evaporators); cooling plants, heat pumps; absorption systems; desiccant and evaporative cooling; boilers; cooling coils, cooling towers; part-load energy performance; energy estimation methods by the bin methods.

**Prerequisites:** Thermodynamics II- MEM310 and Heat Transfer MEM 345

**Textbook(s) and other required material:**

1. Required: Heating and Cooling of Buildings, Kreider, J.F., Curtiss, P.S. and Rabl, A., 2002 2<sup>nd</sup> Edition, McGraw-Hill, New York, NY.
2. Additional handouts as required

**Course Objectives:**

1. Mathematically model and analyze basic psychrometric processes (sensible heating and cooling, cooling and dehumidification, heating and humidification,).
2. Understand, mathematically model and analyze different types of secondary HVAC systems for one zone and multi-zone buildings (all-water, water-air, all-air, new designs)
3. Analyze and design piping and ducting systems, pump and fan performance and selection
4. Model and analyze various equipment: compressors, heat exchangers, heating and cooling coils, and cooling towers
5. Analyze various refrigeration cycles such as Carnot, standard vapor compression, multi-pressure systems and absorption systems
6. Analyze heating systems and equipment such as boilers, furnaces and heat pumps

**Topics:**

1. Introduction: Description of different types of HVAC&R equipment and systems
2. Vapor compression refrigeration cycles and systems
3. Review of psychrometrics and moist air processes
4. Room and unitary equipment (heating and cooling)
5. All-water and air-water HVAC systems including heat pumps
6. All-air HVAC systems (CV, VAV, dual –duct,...)
7. Special HVAC systems (DOAS, underfloor)
8. Hydronic distribution equipment: valves, pump and piping
9. Ducting distribution equipment: dampers, fan and ducts
10. Refrigerants
11. Vapor compression components (compressors, evaporators, condensers, expansion valves, cooling coils and towers)
12. Absorption refrigeration and systems
13. Low energy cooling (economizer cycles, heat recovery, desiccant and evaporative cooling)

**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 professional practice in HVAC&R system design.

**Relationship to Program Outcomes:**

| Outcomes a - k                                                                                                  | Content  | Explanation                                                                                                                                                                                     | Evidence                        |
|-----------------------------------------------------------------------------------------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| a. An ability to apply knowledge of mathematics, science and engineering                                        | <b>3</b> | This is a design course that requires the students to apply their knowledge of thermodynamics and heat transfer as well as synthesize their knowledge of mathematics, science, and engineering. | Homework, Exams, Design Project |
| b. An ability to design and conduct experiments as well as to analyze and interpret data                        | <b>0</b> | None                                                                                                                                                                                            | None                            |
| c. An ability to design a system, component or process to meet desired needs                                    | <b>3</b> | Assignments requiring that students use their mathematical and engineering skills                                                                                                               | Assignments and exams           |
| d. An ability to function on multidisciplinary teams                                                            | <b>0</b> | None                                                                                                                                                                                            | None                            |
| e. An ability to identify, formulate and solve engineering problems                                             | <b>2</b> | The problems require students to identify, formulate and solve quantitative design problems.                                                                                                    | Homework, exams                 |
| f. An understanding of professional and ethical responsibility                                                  | <b>1</b> | Need to design building energy systems as energy efficiently as possible                                                                                                                        | Lecture, assignments            |
| g. An ability to communicate effectively                                                                        | <b>2</b> | Essay assignments to research new equipment and systems                                                                                                                                         | Assignment                      |
| h. The broad education necessary to understand the impact of engineering solutions in a global/societal context | <b>1</b> | How the design of energy efficient HVAC equipment can lead to better energy sustainability                                                                                                      | Lectures, assignments           |
| i. A recognition of the need for and an ability to engage in lifelong learning                                  | <b>2</b> | Stressed the fact that engineers need to keep abreast of new equipment and design practices as well as changing standards and codes                                                             | Lectures, assignments           |
| j. A knowledge of contemporary issues                                                                           | <b>1</b> | Energy issue and how good building and HVAC design can help alleviate the problem                                                                                                               | Lecture                         |
| k. An ability to use the techniques, skills and modern engineering tools necessary for engineering practice     | <b>2</b> | Use of spreadsheet programs and a few specialized HVAC programs for equipment simulation and selection                                                                                          | Homework and special projects   |

**Prepared by:**

Dr. T. Agami Reddy, 7 December 2006