UBC Department of Mechanical Engineering

MECH 473 Heating, Ventilating and Air Conditioning

3 Credits [3-0-1]

Instructor: Professor Steve Rogak Phone 604-822-4149 Rogak@mail.ubc.ca
Office hours (Rusty Hut 103) Wednesday 5-6 (+ additional to be announced)

Lectures: MWF 9-10 Dempster 301

Tutorial: W 6-7pm FSC1221

Prerequisite: MECH 375 (and fluid mechanics and thermodynamics)

Course Description

This course introduces students to the basics of heating, ventilating and air conditioning (HVAC) for buildings. The HVAC engineer's job is to keep the building occupants healthy and comfortable, so students must learn about the temperature, humidity, and air quality requirements. The environmental factors that must be include temperature, humidity, winds, and sunlight- which are dealt with by HVAC engineers in a simplified but technical manner. Students must learn about the way that building envelope structure mediates between indoor and outdoor conditions – mostly as a transient heat transfer and storage medium, but also as a barrier to mass transfer. Finally, if the building cannot provide good indoor conditions passively (and it usually cannot), it is necessary to provide mechanical equipment to heat, cool or ventilate the space.

Specific Learning Objectives

1. Identify (in a schematic and in real life) principle components of an HVAC system.
2. Apply ASHRAE 62 (indoor air quality) in a design setting
3. Apply ASHRAE 55 (thermal comfort) in a design setting
4. Calculate thermal resistance of a building envelope
5. Compute solar gains for different fenestrations.
6. Calculate peak heating loads for a simple building
7. Calculate peak cooling loads for a simple building
8. Calculate annual energy consumption for a simple building.
9. Using psychrometric chart, design processes to obtain a desired T, RH condition.
10. Specify reasonable HVAC system components (fans, ducts, dampers, control systems)

Course Delivery

All students should join ASHRAE and get the ASHRAE Handbook 2013 Fundamentals. The package will cost less than a regular textbook, so you will still have money left over to attend some of the excellent ASHRAE dinner meetings and tours.

The ASHRAE Handbooks, like all handbooks, don't provide many examples and problems. These will be supplied as past homework sets, test problems and selected problems from textbooks. Assignments and exams are described below under grading policy. There will be a field trip and several guest lectures to increase the `real world` content of the course.

Grading Policy

Suggested problems will be distributed in class, including numerical answers.

- A multipart **(total 40% of course)** will follow the basics of building design through from specifying design conditions to calculation of peak loads and energy consumption.
- Midterm (20% of course)
- Final (40% of course)

You must have a passing average on the midterm and final to pass the course.

Project

We will do simplified modelling of the prototype AYO Smarthomes building just north of Pharmacy. This is a simple building suitable for the level of modelling planned, and it is also a REAL building that we can visit. You will model this building for 2 sets of climate data: 1) Vancouver and 2) Beijing

Overall, we must size the HVAC equipment for this building, estimate annual energy consumption for a typical year, and discuss the best options for system design. You may also recommend changes to the architectural design that would reduce the overall HVAC costs. The major parts of this project, due at different times as given in the lecture schedule, are given below (further details to come).

1. Ventilation (5%, January 29) Occupancy schedules will be given; determine the required ventilation based on CO2.
2. Comfort and RH (5%, Feb 12) Compute RH in the building and estimate % satisfaction.
3. Heating load (5 %, Feb 26) Determine heating load for this building using a "design day" using "hand" calculations and using CWEC files and the MATLAB model; assume steady state analysis, neglect solar and internal gains.
4. Transient energy analysis (10%, Mar 18) Calculate cooling loads using the Matlab model considering transient effects, solar gain and internal gains
5. System Design (15%, April 6) Layout and justify 2 HVAC system alternatives. Include ducts and fans for ventilation (7%).