UBC - Department of Mechanical Engineering
MECH 473 - Heating, Ventilating, and Air Conditioning
3 Credits / [3,0,1]

INSTRUCTOR: Dr. N. Atabaki, P.Eng.

Office:
Room 173, ICICS
Phone#: 604 827 4065
E-Mail: natabaki@mail.ubc.ca

OFFICE HOURS: Mon 10:00 to 11:00 ICICS 173
or by appointment (e-mail)

LECTURES: MECH 473 201 Mon/Wed/Fri 9:00 to 10:00 Neville Scarfe 209

TUTORIALS: MECH 473 T2A Wed 18:00 to 19:00 MacLeod 242

TA: NA

PREREQUISITES: MECH 375. Many underlying concepts covered in this course required a good background in Heat Transfer, Thermodynamics, and Fluid Mechanics.

COURSE DESCRIPTION
This course is designed to introduce students to basics of heating, ventilating, and air-conditioning (HVAC) for buildings. The following topics will be discussed: Analysis of simple HVAC systems; introduction to meteorological data and design conditions; solar angles and solar radiations; heat and moisture transfer in building envelope; heating and cooling load calculations; analysis and understanding of different processes that moist air undergoes in most common HVAC systems; psychrometric, indoor air quality (IAQ); and thermal comfort.

COURSE LEARNING OBJECTIVES (CLO)

1. Think critically about different aspects that influence the heating and air-conditioning of buildings;
2. Critically examine the interactions between the thermal comfort of occupants, the indoor air quality, and the energy consumption;
3. Develop a comprehensive and integrated HVAC designing skills
4. Demonstrate reputable use of ethical principles when designing an HVAC system
5. Work eventually in engineering fields

Specific Objectives

At the end of this course, it is expected that students will able to:

- Identify the principal components of a heating/air-conditioning system;
- Distinct difference between the peak heating/cooling load and energy consumption;
- Calculate the energy consumption for a simple system by taking into account the efficiency of machines;
- Determine the design conditions;
- Calculate the thermal resistance of the building envelope;
- Calculate the solar radiation incident on a surface oriented arbitrary
- Calculate the heating loads
- Calculate the cooling load using RTS method
- Calculate the properties of a water-vapor/air mixture using basic equations;
- Use the Psychrometric chart;
- Explain different processes that undergoes the water-vapor/air mixture in most common HVAC systems;
- Specify different air contaminants;
- Apply a mass balance for determination of the contaminant concentration inside spaces
- Apply the Standard 62 of ASHRAE;
- Specify the factors important for thermal comfort of occupants;
- Calculate the mean radiant temperature;
- Apply the Standard 55 of ASHRAE.

LEARNING ACTIVITIES: Generally, each lecture will start with review of the topics to be covered, then after teaching the core lecture, I will do some problems in the class related to the subject covered. Homeworks are in the form of problem sets where answers are provided. Students work on them, and the TA will solve these problems in the tutorial session. There are also mini-projects that link the materials learned in the class to practical problems.

COURSE MATERIALS
Instructor's handouts will be posted on Connect.

TEXTBOOK

The following Textbook is a good reference for this course (buying is **optional**):

Heating, Ventilating, Air Conditioning – Analysis and Design
F.C., McQuiston, J.D., Parker, and J.D., Spitler, 6th Edition, Wiley, 2005.

GRADING POLICY

Suggested Homeworks (**0%**)
7-8 Problem Sets will be distributed in class; these are **recommended**; **NOT** to be turned in for grading.

Mini Projects (15%) [CLO's 1-5]
Two mini projects (both required) will be assigned.
Mini project # 1 - (**6.5%**) **Given:** Friday, Jan. 31; **Due:** Friday, Feb. 14.
Mini project # 2 - (**8.5%**) **Given:** Monday, March 09; **Due:** Friday, March 27.

Each project should be done *in group of two (except for graduate students that should work individually).*
Projects involve direct implementation and application of what discussed in lectures on simple problems. For each project, a downloadable template file (Microsoft Excel) will be provided on Connect.

Midterm (30%) [CLO's 1,3,4]
A 50 min midterm exam is designed to be held on **Wed February 26,** 2020, starting at 9:00 in Neville Scarfe 209

Final Exam (55%) [CLO's 1,3,4]
Date and location of the final exam will be determined later.

LIST OF TOPICS

	Estimated Length
1) Introduction to HVAC systems	1 week
2) Design outdoor and indoor conditions	½ week
3) Solar angles and radiations	1 week
4) Building Envelopes	2 ½ weeks
5) Infiltration	½ week
6) Heating and Cooling load calculations	2 weeks
7) Psychrometric	2 weeks
8) Indoor Air Quality, ASHRAE Std., 62.1-2004	1 week
9) Thermal comfort, ASHRAE Std., 55-2004	1 week
Additional Activities:	
Field Trip/ Guest Speakers	½ week

REFERENCES

The following textbooks and handbooks are additional references for this course:

1. **Thermal Environmental Engineering**,
   T.H. Kuehn, J.W., Ramsey, and Threlkeld, J.L., 3rd Edition, Prentice Hall, 1998.

2. **Eléments de mécanique du bâtiment** (in French)
   M., Bernier, Ecole Polytechnique de Montréal, 1998.

3. **ASHRAE Handbooks**
   b) **Fundamentals 2017**
   c) **HVAC Systems and Equipment 2016**
   d) **HVAC Applications 2015**
   e) **Refrigeration 2014**

   American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., SI Edition, Atlanta, USA.

4. **HVAC Simplified**
   S.P., Kavanaugh, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, 2006.

5. **Principle of Heating Ventilating and Air Conditioning**
   R.H., Howell, H.J., Sauer Jr., and W.J., Coad, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, 2005.

6. **HVAC Handbook**
   R.C., Rosaler, McGraw Hill, 2004.

7. **Heating, Cooling, Lighting – Design Methods for Architects**
   N. Lechner, 2nd Edition, Wiley, 2004.

8. **ASHRAE Standard 55-2017, Thermal Environmental Conditions for Human Occupancy,** American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta.

9. **ASHRAE Standard 62.1-2017, Ventilation for Indoor Air Quality**
   American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta.

10. **Principles of Engineering Thermodynamics**
    M.J., Moran, and H.N., Shapiro, 5th Edition, Wiley, 2004.

11. **Principles of Heat Transfer**
    F., Kreith, and M.S., Bohn, 6th Edition, Brooks/Cole, Pacific Grove, California, 2001.

12. **Fundamentals of Heat and Mass Transfer**
    F.P., Incropera, and D.P., DeWitt, 7th Edition, Wiley, 2011.