[Spring 2022] 4013.205 Thermal energy fundamentals in buildings (건물열에너지 이론)

Instructor: Cheol-Soo Park (Office: 39-430, Tel: 02-880-4305, cheolsoo.park@snu.ac.kr)
Place and time: Building #39, Room 409, Tue. 3:30-4:45 p.m., Th.: 3:30-4:45 p.m.
Zoom: https://snu-ac-kr.zoom.us/j/7588076550
Office Hours: Th. 5:00-5:30 p.m. (by appointment)
T.A.: Chul Hong Park (Building Simulation Lab, chulhong.park@snu.ac.kr)

Objectives:
- **Learn the fundamentals of building energy analysis**: building physics [conduction, convection, radiation], internal heat gains, infiltration, ventilation, fenestration, occupant behavior)
- **Learn** cooling and heating **load calculation principles and methods** for nonresidential buildings
- **Understand** the impact of architectural design variables on building energy use as well as how to achieve energy-efficient building design.

Textbooks:
- Selected chapters. Grondzik, W. and Kwok, A. (2019), Mechanical and electrical equipment for buildings, 13th edition. Wiley (MEEB book), e-book available at the SNU library (https://ebookcentral.proquest.com/lib/snulibrary-ebooks/home.action)
  - ◼ The building design context
    - ◆ Ch.1 Design process
    - ◆ Ch.2 Environmental resources
    - ◆ Ch.3 Sites and resources
  - ◼ Design fundamentals
    - ◆ Ch.4 Thermal comfort
    - ◆ Ch.9 Heat flow
  - ◼ Passive environmental systems
    - ◆ Ch. 11 Passive heating (selected sections)
      - 11.2 Degree days
      - 11.5 Estimating the Balance-Point Temperature
    - ◆ Ch.12 Passive cooling (selected sections)
      - 12.6 Approximate Method for Calculating Heat Gain (Cooling Load)
      - 12.7 Detailed Hourly Heat Gain (Cooling Load) Calculations
  - ◼ Active environmental systems
    - ◆ Ch.14 Active climate control (selected section: 14.4 Fundamentals)
- Selected chapters. Heating, ventilating and air conditioning: analysis and design. McQuiston, F., Parker, J., and Spitler. J. 6th edition. John Wiley & Sons, Inc.
  - ◼ Ch.5 Heat transmission in building structures
  - ◼ Ch.6 Space heating load
  - ◼ Ch.8 The cooling load

References:
- ASHRAE handbook Fundamentals. 2017 (*to be distributed*)
  - ◼ Ch.18 Nonresidential cooling and heating load calculations
  - ◼ Ch.15 Fenestration
  - ◼ Ch.17 Residential cooling and heating load calculations

- ■ Ch.26 Heat, air and moisture control in building assemblies – material <u>properties</u>

Homework: Homework will be assigned approximately 3-4 times in the term**.**

Projects:
- ● Project I: heating load calculation
- ● Project II: cooling load calculation using ASHRAE Radiant Time Series (RTS) method *(tentative)*

Exams: One mid-term exam and a final exam.

Grading:
Grades for homework/projects will be based on completeness, accuracy, presentation and understanding of the key concepts. All assignments (homework, project) will be collected at the beginning of class on the stated due date. No project will be accepted after the scheduled due date and time. A grade of 0 will be assigned for that project. If a homework (project) conflicts with other class' project/exam/site visit, you must inform the instructor at least one class period before the homework/project is due, if you wish the instructor to consider extending the due date. Grades will be determined as follows.

Attendance 5% + Homework 5% + Project I (10%) + Project II (10%) + mid-term exam (35%) + final term exam (35%)

Attendance
Arrive on time. You are strongly encouraged to regularly attend class. Missing three classes will reduce your final grade by one letter. Missing four times or more will reduce your final grade by two letters or to F.

Schedule:
- ● Week 1: motivation, Ch.1 Design process
- ● Week 2: Ch.1 Design process (HW #1 out) / Ch.2 Environmental resources
- ● Week 3: Ch.2 Environmental resources (HW #2 out)
- ● Week 4: Ch.3 Sites and resources (HW #3 out)
- ● Week 5: Ch.9 Heat flow / McQuiston book Ch.5
- ● Week 6: Ch.9 Heat flow / McQuiston book Ch.5
- ● Week 7: Ch.9 Heat flow / McQuiston book Ch.5
- ● Week 8: mid-term exam
- ● Week 9: Ch.11, Ch.12 passive heating & passive cooling
- ● Week 10: McQuiston book Ch.6, Ch.8 / ASHRAE F 2017 (Cooling load calculation principles)
- ● Week 11: McQuiston book Ch.6, Ch.8 / ASHRAE F. 2017 (internal heat gains, fenestration, conduction, time delay effect)
- ● Week 12: McQuiston book Ch.6, Ch.8 / ASHRAE F. 2017 (Examples of heating and cooling load calculation: room by room, block model)
- ● Week 13: Implementation of the RTS method using ASHRAE RTS spreadsheet (Project I, II out)
- ● Week 14: Ch.14 Active climate control (section 14.4 Fundamentals)
- ● Week 15: final exam