CIVL4100N – Energy System Modeling for Buildings and Cities

Syllabus

Instructor

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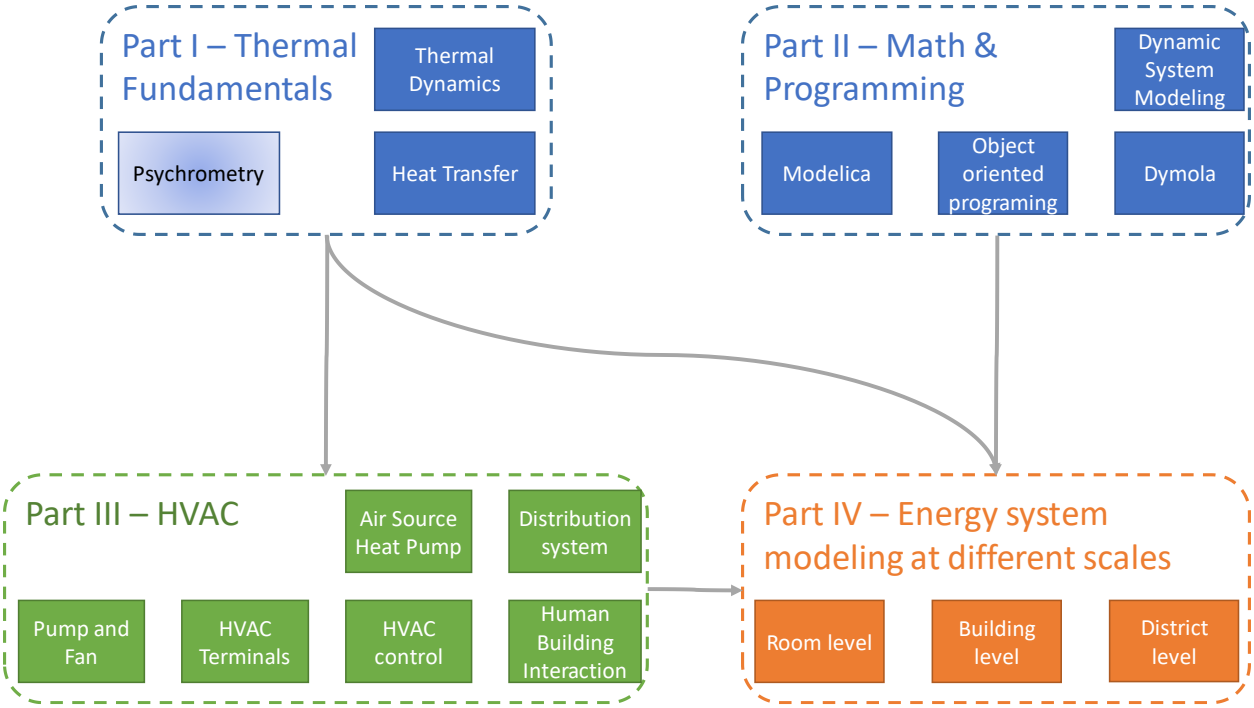
Course description

Energy system is an important part of smart low-carbon buildings and cities. Energy system modelling is the prerequisite for load prediction, energy efficiency design and optimization, which becomes increasingly important under the context of climate change and sustainable development.

This course provides theory and hands-on experience about energy system modelling for buildings and cities. Lectures will cover physical concepts, mathematical laws, and software tools for city and building energy system modelling. On the theory side, this course will cover heat transfer basics and building thermal dynamics. On the practical side, this course will introduce the equation-based programming language Modelica. On the scale side, this course will cover building-scale energy system (HVAC) and the city-scale energy system (district heating and cooling system).

This course has four modules as shown below: review of thermal fundamentals, math and programming of dynamic systems, major components of HVAC system, and energy system modeling at different scales.


Part I – Thermal Fundamentals
Thermal Dynamics
Psychrometry
Heat Transfer
Part II – Math & Programming
Dynamic System Modeling
Modelica
Object oriented programing
Dymola
Part III – HVAC
Air Source Heat Pump
Distribution system
Pump and Fan
HVAC Terminals
HVAC control
Human Building Interaction
Part IV – Energy system modeling at different scales
Room level
Building level
District level

Calendar

Week	Date	Lecture	Lab session	Assignment
1	8th Feb.	Introduction		
	10th Feb.	Review I - Thermal dynamics		
2	15th Feb.	Review II - Heat transfer I		
	17th Feb.	Review III - Heat transfer II		H1 released
3	22nd Feb.	Room level thermal dynamics		
	24th Feb.	Dynamic system modeling I		H1 due
4	1st Mar.	Dynamic system modeling II		
	3rd Mar.	Modelica I – introduction		
5	8th Mar.	HVAC overview	Lab1. Solving ODE and PDE	
	10th Mar.	Modelica II – OOP		H2 released
6	15th Mar.	HVAC heat source	Lab2. Simple envelope model	
	17th Mar.	Modelica III – Room level modeling		H2 due
7	22nd Mar.	HVAC heat pump I	Lab3. Using MixedAir model	
	24th Mar.	HVAC heat pump II		
8	29th Mar.	HVAC distribution system		Project topic confirmation
	31st Mar.	Pump and fan		H3 released
9	5th Apr.	*Holiday*	Lab4. Building energy modeling	
	7th Apr.	Modelica Buildings Library		H3 due
10	12th Apr.	Modeliva IV – Building level modeling		
	14th Apr.	*Mid term break*		
11	19th Apr.	HVAC terminal		
	21st Apr.	Human building interaction		
12	26th Apr.	Project presentation		
	28nd Apr.	HVAC control		Pro. Rep. due
13	3rd May	District heating and cooling system I		
	5th May	District heating and cooling system II		
14	10th May	Course Review		

Grading

- Assignments: 10%*3
- Project: 30%
- Final exam: 40%

Assignments

Three homework assignments let you practice and apply the concepts learned in lecture and section. They will usually be released on Thursday night and be due the following Thursday midnight (23:59 pm).

Assignment late policy

All assignments must be turned in on time (deadline is 23:59 pm Thu.). We will allow a total of five late days (Weekends and holidays counted) cumulatively. We will not make any additional allowances for late assignments: the late days are intended to provide for exceptional circumstances, and students should avoid using them unless absolutely necessary. Any assignments that are submitted late (with insufficient late days remaining) will not be graded.

Project

The project is aimed to let you practice and apply the concepts of building energy system modeling and the Modelica language learned in lecture and lab sessions. 2 people will form a group. You need to present your project and submit a project report by the end of the semester.

Integrity

Cheating is not allowed for either assignments or exams.

All assignments should be done individually. You are allowed to discuss homework questions with other students, but not allowed to copy solutions or share your solution to a question with other students who haven't completed the question already. Cheating on assignments or final exam results in 0 points, so you really do not want to cheat.

Please, do your own work. Thank you!

Citizenship

A diversified, inclusive and equitable environment would benefit everyone of our community. For exceptionally rude or disrespectful behavior toward the course staff or other students, your final grade will be lowered by up to a full letter grade (e.g., from an A- to a B-) at the discretion of the course instructors. You don't need to be concerned about this policy if you treat other

human beings with even a bare minimum of respect and consideration and do not engage in behavior that is actively harmful to others.

Office hour

- Time: 3-5 pm every Wed.
- Venue: Room 3564

Reference

- Stanford, H.W. and Spach, A.F., 2019. Analysis and Design of Heating, Ventilating, and Air-Conditioning Systems. CRC Press. (electronic version is available in the HKUST library)
- Modelica by Example: https://mbe.modelica.university/