CAE 464/517 HVAC Systems Design

Spring 2021

January 19, 2021

Course Overview and Intro to CAE 464/517

Built
Environment
Research
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Civil, Architectural and Environmental Engineering
Illinois Institute of Technology
muh182@iit.edu

INTRODUCTION

About Me

- B.S.E., Mechanical Engineering
  - ❑ Sharif University of Technology Tehran, Iran, 2006
- M.S.E., Architectural Engineering
  - ❑ The Pennsylvania State University, 2011
- Ph.D., Mechanical Engineering
  - ❑ The Pennsylvania State University, 2014

- Experience relevant to this course
  - ❑ ASHRAE, DOE, HUD, NSF, and industry projects
  - ❑ University of Maryland College Park
  - ❑ Licensed Professional Engineer
  - ❑ ASHRAE New Investigator
  - ❑ Taught CAE 464, CAE 465/526, CAE 438/538, CAE 553, ENVE 576

Introduce Yourself

- Please introduce yourself
- Why did you choose this course (besides being required)?
- What do you expect from the course?
- How do you think the course will have impact on your career?
- Do you have any relevant internship/work experience?
- Are you looking for summer internship or full-time job?
- Did you take your FE exam?
- Are you graduating this semester?

Course

Classroom and Meeting Time:

- ❑ CAE 464 Section 01: 24202 (undergraduate)
- ❑ CAE 517 Section 01: 51444 (graduate)

Classroom and Meeting Time:

- ❑ Location: Herman Hall Mezzanine (In-Person Classes TBD)
- ❑ Tuesdays and Thursdays, 3:35 PM – 4:50 PM

Course Website:

- ❑ All content will be provided on Blackboard
- ❑ Additional software training videos will be provided

Course

<u>COVID-19 Update, January 18, 2021</u>: This class is listed under the new classroom delivery methods for Spring 2021 as a Hybrid (S) course, meaning that there is a classroom reserved on the day and time it is scheduled to meet, and lectures have the ability to be streamed live and also recorded and made available for remote viewing after each class period. Thus, Hybrid (S) can accommodate in-person activities if instructors and/or students choose to do so, as well as fully remote with a live stream occurring at the same day/time as class (with the live stream recording also available for asynchronous viewing).

Course

Out of an abundance of caution, at least the first 2 weeks of the semester will be held entirely online (more info for the university's COVID related policy is accessible here: https://www.iit.edu/COVID-19/fall2020. In this course, I will reassess the situation after these first two weeks to determine exactly how the course will be delivered and how frequent (if at all) I will be in person. And regardless of which section you're enrolled in for this course, this course can be taken entirely remotely (online) if you wish. There is no need to change your registration to do so. If you wish to be in-person, there is a classroom scheduled and you're welcome to use it, whether not I am there each time (still TBD). We will assess everyone's preferences in the first week, and further plan from there.

For the online lectures, please remind me to click on the **RECORD** button if I forget!

Course Catalog Description

- Study of the fundamental principles and engineering procedures for the design of heating, ventilating, and air conditioning systems
- HVAC system characteristics
- System and equipment selection
- Duct design and layout
- Attention is given to energy conservation techniques and computer applications

Instructor's Course Objectives & Learning Outcomes

To introduce students to both theory and applied design procedures for HVAC equipment and systems. By taking this course students will be able to:

1. Understand fundamentals of fluid and energy flows for HVAC equipment and systems
2. Design and size air distribution systems, hydronic systems, and refrigeration systems
3. Design, draw, and read mechanical drawings
4. Design, review, and assess different HVAC designs
5. Propose recommendations to revise HVAC designs and retrofit existing HVAC systems
6. Utilize both hand calculations and computer modeling (graduate students) for sizing air distribution systems, hydronic systems, and refrigeration systems

Office Hours

Instructor:

- As always, I'm available via email. If you would like to schedule a virtual meeting, I'm accessible via Google Hangout (my id is mheidarinejad@iit.edu or muh182@iit.edu). Just send me a text on these handles. If I am available, we can meet virtually. You're more than welcome to email me to schedule a time for a virtual meeting.
  - Email: muh182@iit.edu

Office Hours

Teaching Assistant:

- TBD
  - ❑ Name: Jongki Lee, Ph.D. Student, Architectural Engineering
  - ❑ Email: jlee310@hawk.iit.edu

Textbook

- 2017 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook of Fundamentals (IP unit version)
- The ASHRAE Handbook of Fundamentals isn't exactly a textbook, but rather is a deep and authoritative resource for many aspects of building engineering
- We reference it directly for almost every topic in this class, and you will also continue to use it in future required and elective courses, including CAE 463/524 Building Enclosure Design, CAE 465 Energy Conservation Technologies, CAE 495 Capstone Senior Design, and several others

Textbook

- The ASHRAE Handbook of Fundamentals costs $209 to the general public, but costs only $54 to ASHRAE student members. And ASHRAE student membership is only $25 per year

- You can purchase the handbook and a student membership (if you aren't already a member) online: https://www.ashrae.org/communities/student-zone/membership-and-meetings/student-membership-benefits.

Textbook

- Note that ASHRAE publishes several different types of "handbooks." You should purchase the "Fundamentals" handbook from 2017. You can purchase a hard copy of the ASHRAE Handbook of Fundamentals (it is sold in hardcopy in IP and SI units separately). The hard copy also comes with a CD with both SI and IP versions of the Handbook on it, so you will have access to both even if you buy the IP hardcopy version. Or you can purchase soft copies only from the site, as you wish.

- For this semester, Dr. Stephens will have hardcopies of the IP unit version of the ASHRAE Handbook of Fundamentals (it is sold in hardcopy in IP and SI units separately). The hard copy also comes with a CD with both SI and IP versions of the Handbook on it, so you will have access to both even if you buy the IP hardcopy version.

References

In addition to the ASHRAE Handbook of Fundamentals, I will also rely on several other materials in this course. These materials are entirely optional for the student; handouts will be given when necessary so that no one is required to purchase these items:

- McQuiston, F.C., Parker, J.D., Spitler, J.D., *Heating, Ventilation, and Air-Conditioning Analysis and Design*, John Wiley & Sons, Inc., 6th Edition, 2005.
- Reddy, T.A., Kreider, J.F., Curtiss, P.S., Rabl, A., *Heating and Cooling of Buildings: Principles and Practices of Energy Efficient Design*, CRC Press, 3rd Edition, 2017.
- Sugarman, S.C., *HVAC Fundamentals*, CRC Press, 3rd Edition, 2016.
- Engineer's HVAC Handbook, Edition 1.1, Price Industries
- 2018 ASHRAE Handbook: Refrigeration, ASHRAE, 2018.
- 2019 ASHRAE Handbook: HVAC Applications, 2019.
- 2020 ASHRAE Handbook: HVAC Systems and Equipment, 2020.

GRADING AND COURSE POLICIES

Course Grading

Grading	Quantity	% of Total for Each	% of Total
Homework	8	3.5	28
Midterm Exam	1	32	32
Project Report 1	1	7	7
Project Report 2	1	7	7
Project Report 3	1	7	7
Final Project Report	1	12	12
Final Project Presentation	1	7	7

Grading scale	A	B	C	D	F
UG and G	90% and up	80.0-89.9%	70.0-79.9%	60.0-69.9%	<60.0%

Homework Assignments

- There will be a total of ***8 homework*** assignments
- Homework sets will be assigned based on lecture coverage
- The homework will involve hand calculations, development of spreadsheets, modeling, and/or learning the fundamentals and data analysis
- Each homework will be assigned ***at least a week before*** the homework due date. You must work on the homework assignments ***individually***

Project

- The project focuses on design of air distribution, hydronics, and refrigeration system designs

- The first three parts are designed to assess student's ability to design air distribution, hydronic distribution, and refrigeration systems stand-alone

- The final project submission is an integrated design focusing on integration of air distribution designs with the refrigeration and hydronic systems

- Group of ***two to three students*** can work on the group assignments and submit one submission per group

Final Presentation

- Students are required to present the final project and submit the ***design documents***, including ***mechanical drawings*** on the ***final exam day scheduled by the university***

- Students are required to ***present online***

Class Activity

- To ensure that both in-class and online students can benefit from the class activity, students are required to participate in the class discussion

- Students who signed up for the online section or students who do not attend the class need to work on the class activity during the week and submit the class activity report by the end of each week

- Class attendance is required unless it is coordinated with the instructor

Exam

- There will be ***one mid-term*** exam focused on the fundamental concepts learned in the course

- The exam is a ***take home exam***

Late Homework Assignment and Report Policy

- Homework assignments and project reports are due at the ***midnight on the day that it is due***

- Homework assignments and project reports will receive a ***5-point deduction*** for every day that it is late before the solution is posted on Blackboard

- After the ***solution is posted***, the blackboard submission page ***is closed for that particular homework***

Course Topics

Week	Date	Topics	Reading	Assignment Due
1	01/19/21	**Course Overview & Introduction:** Grading (exams, homework, projects), expected skills, and knowledge outcomes		
	01/21/21	**Introduction to HVAC:** Review of HVAC system drawings and installation in real buildings	F38, F39	
2	01/26/21	**Review HVAC Thermodynamics:** Moist air properties, Psychrometric chart, sensible and latent heat	F1	
	01/28/21	**Review of Fluid Flows:** Fluid flow basics and conservation of energy applied to flows (CAE 208 & CAE 209)	F3	HW 1
3	02/02/21	**Building Loads:** Building heating and cooling load calculations	F14, F17, F18	
	02/04/21	**Building Loads:** Building cooling load calculations	F14, F17, F18	
4	02/09/21	**No Class (COVID Study Day)**		HW 2
	02/11/21	**Building Loads:** OpenStudio Training	F14, F17, F18	
5	02/16/21	**Air Distribution Systems:** Diffuser design and selection, diffuser operational principles, zone location selection criteria, device selection	F20, F21	HW 3
	02/18/21	**Air Distribution Systems:** Fan selection, system effects on performance, affinity laws	F20, F21	

Course Topics

Week	Date	Topics	Reading	Assignment Due
6	02/23/21	**Air Distribution Systems:** Fan output controls and energy utilization, pressure loss in ducts and fittings	F20, F21	HW 4
	02/25/21	**Air Distribution Systems:** REVIT Training		
7	03/02/21	**Air Distribution Systems:** Duct system design, equal friction method, comparison of different design solutions	S20, S21	HW 5
	03/04/21	**Air Distribution Systems:** Constant Air Volume (CAV), Variable Air Volume (VAV), and Dedicated Outdoor Air Systems (DOAS)	S20, S21, S51	
8	03/09/21	**Hydronic Systems:** An overview of HVAC hydronic systems (e.g., boilers, chillers, cooling powers)	F22, S13, S32	Project Part 1
	03/11/21	**Midterm Exam**		
9	03/16/21	**Hydronic Systems:** System characteristics and fluid flow, steam system design, system operation and sizing system components	F22, S36	
	03/18/21	**Hydronic Systems:** Centrifugal pumps, operating characteristics, selection parameters influencing performance, affinity laws, combining pump and characteristic curves in system design	F22	

Course Topics

Week	Date	Topics	Reading	Assignment Due
10	03/23/21	**Hydronic Systems:** REVIT Training		
	03/25/21	**Hydronic Systems:** Pipe system fundamentals fitting coefficients, and equivalent length estimations of ΔP- system	F22	HW 6
11	03/30/21	**Hydronic Systems:** control strategies, technology for hydronic systems, 2-way & 3-way valves	F22	
	04/01/21	**Refrigeration:** T-s and P-h diagrams, and space conditioning (CAE 331)	F2	Project Part 2
12	04/06/21	**Refrigeration:** Introduction to vapor compression cycles and examples	F2	
	04/08/21	**No Class (COVID Study Day)**		
13	04/13/21	**Refrigeration:** Vapor compression cycle applications	F2, F30	
	04/15/21	**Refrigeration:** Potential environmental impacts of refrigerants (global warming, ozone depletion)	F2, R18	HW 7
14	04/20/21	**Refrigeration:** Cooling Towers	S40	
	04/22/21	**Refrigeration:** Absorption cooling (Principles of operation and cycle analysis)	F2	

Course Topics

Week	Date	Topics	Reading	Assignment Due
15	04/27/21	**HVAC Systems Design:** Integrated Design		Project Part 3
	04/29/21	**HVAC Systems Design:** Integrated Design		
16	05/04/21	**HVAC Systems Design:** Applications (VRF and Chilled Beams)	S5	HW 8
	05/04/21	**HVAC Systems Design:** Applications (Water Source and Ground Source Heat Pumps)		
17	TBD	**Final Project Presentation (Integrated Design)**		Final Presentation
	05/15/21	**Final Project Report (Integrated Design)**		Final Report

Academic Honesty

- It is your responsibility to be familiar with IIT's Code of Academic Honesty. The Code of Academic Honesty can be found online: http://www.iit.edu/student_affairs/handbook/information_and_regulations/code_of_academic_honesty.shtml

- You must submit your ***own work for homework***. You are encouraged to discuss and even work with other students on homework (unless explicitly told otherwise), but material that is submitted must be ***your own work***. For group project assignments, each group is to submit their own work

Academic Honesty

- For a ***first violation*** of the IIT Code of Academic Honesty for a homework or project, the homework will receive a grade of ***zero for all involved students*** and the students will be reported to the Designated Dean for Academic Discipline (DDAD)

- For a first violation of the Code of Academic Honesty for a ***major project*** or an examination, the student will ***receive a failing grade*** for the course and the student will be reported to the DDAD. For a second violation, the student will receive also failing grade for the course and be reported to the DDAD

Personal Problems

- If you have illness or personal problems that will affect your performance during the course of the semester, please let me know ***as soon as possible***

- ***"After the fact"*** provides little protection unless there are extreme circumstances. Contact the instructors by phone or e-mail at any time

Personal Problems

- Academic Regulations: https://web.iit.edu/student-affairs/handbook/fine-print/academic-and-department-regulations

*"All students are **expected to attend classes regularly**. Excessive absences may be grounds for a failing grade. Non-attendance does not constitute an official withdrawal. When illness or emergency requires a student to miss an exam and/or more than two days of class, the student must notify the course instructor. It is also recommended that the student **contact the office of the Dean of Students (dos@iit.edu) to request an excused absence.** It will be necessary to provide written documentation of the reason for the absence(s). The Office of Student Affairs manages the process for requesting and documenting excused absences but the decision to excuse an absence is generally made by the Professor. Faculty members determine their own policies for attendance and make-up work."*

Students with Disabilities

- Reasonable accommodations will be made for students with documented disabilities. In order to receive accommodations, students must obtain a letter of accommodation from the Center for Disability Resources

- The Center for Disability Resources (CDR) is located in Life Sciences Room 218, telephone (312) 567-5744 or email: disabilities@iit.edu

Sexual Harassment and Discrimination Information

- Illinois Tech prohibits all sexual harassment, sexual misconduct, and gender discrimination by any member of our community. This includes harassment among students, staff, or faculty. Sexual harassment of a student by a faculty member or sexual harassment of an employee by a supervisor is particularly serious. Such conduct may easily create an intimidating, hostile, or offensive environment.

- Illinois Tech encourages anyone experiencing sexual harassment or sexual misconduct to speak with the Office of Title IX Compliance for information on support options and the resolution process.

Sexual Harassment and Discrimination Information

- You can report sexual harassment electronically at iit.edu/incidentreport, which may be completed anonymously. You may additionally report by contacting the Title IX Coordinator, Virginia Foster at foster@iit.edu or the Deputy Title IX Coordinator at eespeland@iit.edu.
- For confidential support, you may reach Illinois Tech's Confidential Advisor at (773) 907-1062. You can also contact a licensed practitioner in Illinois Tech's Student Health and Wellness Center at student.health@iit.edu or (312)567-7550
- For a comprehensive list of resources regarding counseling services, medical assistance, legal assistance and visa and immigration services, you can visit the Office of Title IX Compliance website at https://www.iit.edu/title-ix/resources.

WHY DO WE LEARN ABOUT HVAC?

Why Do We Learn About HVAC

https://www.kemptoncarr.co.uk/news-and-knowledge/is-damp-or-poor-ventilation-ruining-your-home/
https://www.goldeagle.com/tips-tools/mold-vs-mildew-whats-difference/

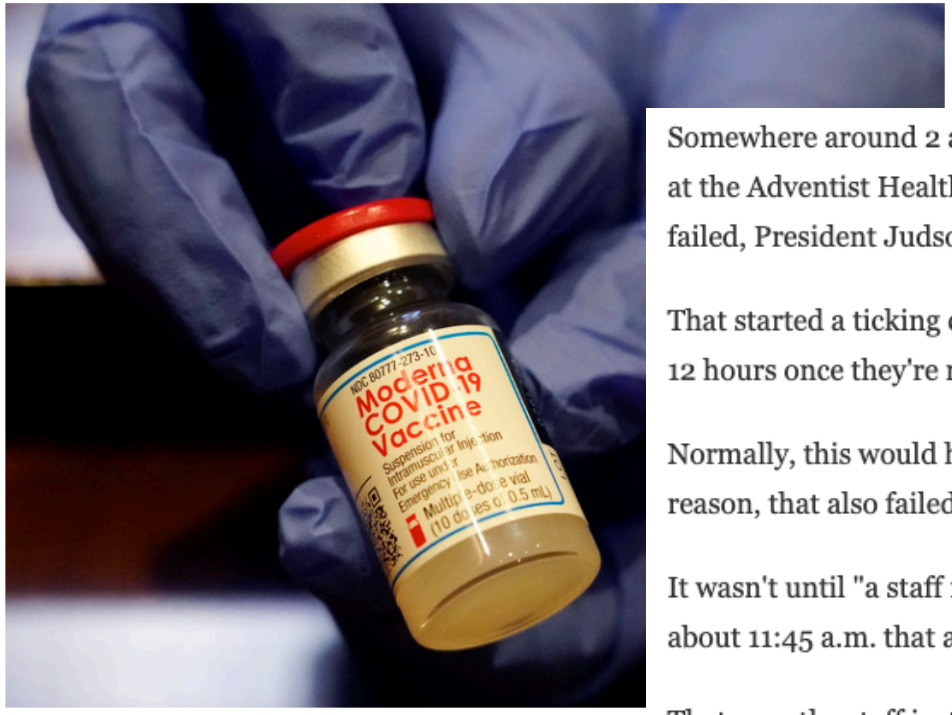
Why Do We Learn About HVAC

THE CORONAVIRUS CRISIS

Hospital Scrambles To Find Patients Before Freezer Failure Ruins 830 Vaccines

January 5, 2021 · 9:12 PM ET

VANESSA ROMO



Somewhere around 2 a.m. the compressor of the freezer holding vials of the medicine at the Adventist Health Ukiah Valley Medical Center in Mendocino County, Calif., failed, President Judson Howe told NPR.

That started a ticking clock on the shelf life of the vaccines, which can only be used for 12 hours once they're removed from refrigeration of 36 to 46 degrees Fahrenheit.

Normally, this would have triggered an alarm, Howe explained. But for some unknown reason, that also failed.

It wasn't until "a staff member physically checked it — stuck his hand in the freezer" at about 11:45 a.m. that anyone realized something was grievously wrong.

That gave the staff just over two hours before the vaccines would be declared unusable.

https://www.npr.org/sections/coronavirus-live-updates/2021/01/05/953779007/hospital-scrambles-to-find-patients-before-freezer-failure-ruins-830-vaccines#:~:text=A%20team%20of%20fast%2Dacting,the%20Moderna%20COVID%2D19%20vaccine.

Why Do We Learn About HVAC

NYC Department of Education

Select Language

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Powered by Google Translate

Enrollment | School Year 2020-21 | Learning | School Life | Get Involved

Home ▸ About Us ▸ Insights and Reporting ▸ School Building Ventilation Survey

School Building Ventilation Survey

We look forward to kicking off the 2020-2021 school year together with you. As always, the health and safety of our staff, students and families is our number one priority.

Properly ventilated classrooms are key to our reopening our schools safely. We have been working around the clock to ensure that every school has been carefully surveyed for ventilation by consulting engineers under the direction of the New York City School Construction Authority. The results of your child's school building ventilation survey will be posted on the individual school page on our website, on the Overview tab, under Building Ventilation Information.

- **Use Find a School to get your school page and see the report.**

We found that the ventilation in more than 95 percent of our classrooms is in good working order. Out of the 64,000 classrooms we surveyed, fewer than 3,000 had issues. These results for individual schools are preliminary and are intended to help focus our repair and maintenance efforts. They do not indicate any space's ability to open, as we are continuing to repair and correct any outstanding ventilation issues.

https://www.schools.nyc.gov/about-us/reports/school-building-ventilation-survey

Why Do We Learn About HVAC

Chicago Public Schools

PARENTS STUDENTS COMMUNITY STAFF

SELECT LANGUAGE ▼

Schools Academics Services Initiatives Calendar Blog About

SERVICES AND SUPPORTS

- School Facilities
- Facility Standards
- Air Quality Testing
- Water Quality Testing
- Capital Improvement Program Support
- Emergency Temporary Relocations

HOME / SERVICES AND SUPPORTS / SCHOOL FACILITIES

Ventilation and Indoor Air Quality Assessment

As we have committed to you and your family throughout our response to COVID-19, the health and wellness of our school communities is paramount.

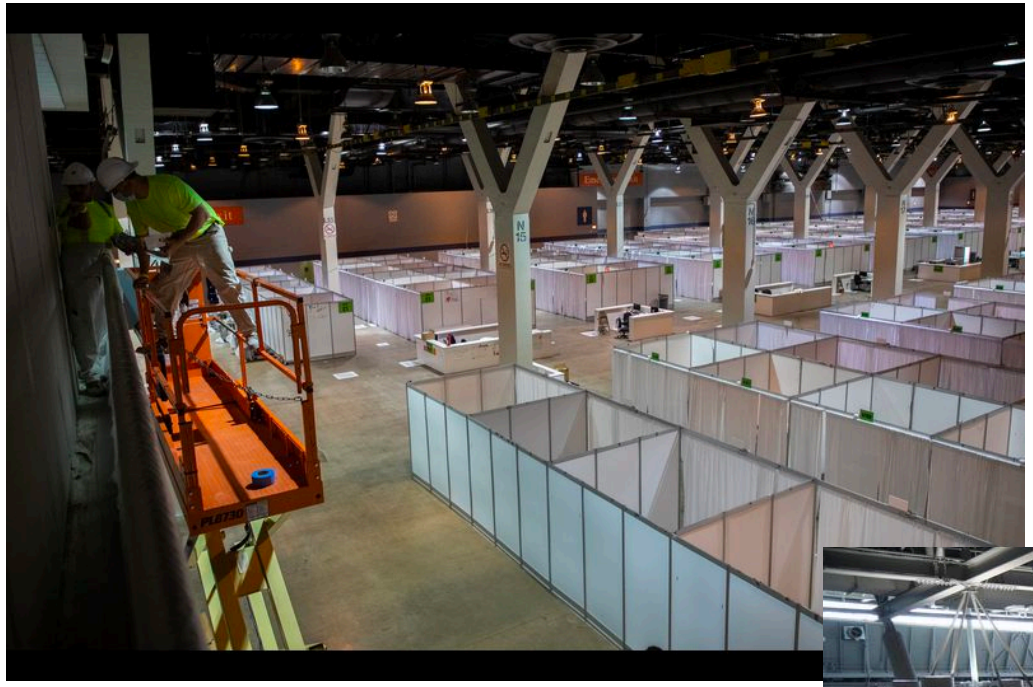
To ensure school buildings are prepared for a return to in-person instruction, we worked to ensure every classroom has a working window or a mechanical ventilation system to dilute air particles that may have viruses or bacteria and allow old air to move out of the classroom.

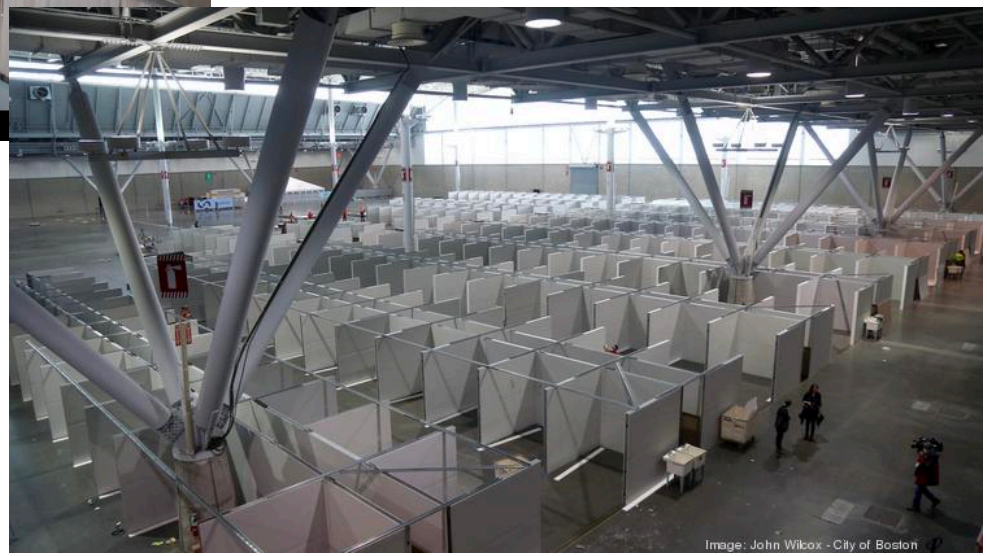
https://www.cps.edu/services-and-supports/school-facilities/air-quality-testing/

Why Do We Learn About HVAC

https://twitter.com/drzoehyde/status/1331499374795321344?s=11

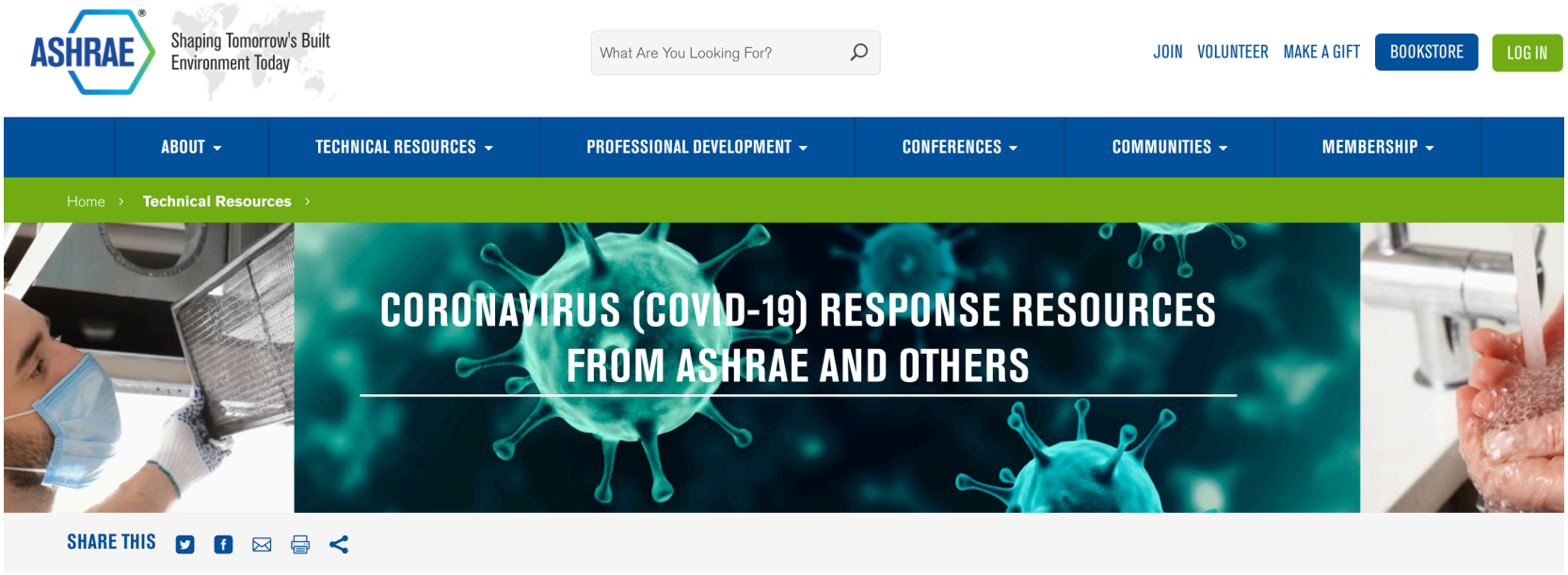
Why Do We Learn About HVAC

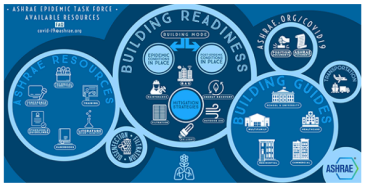




https://www.bizjournals.com/boston/news/2020/04/06/a-look-inside-the-new-field-hospital-at-the-boston.html
https://www.chicagotribune.com/coronavirus/ct-coronavirus-mccormick-place-convert-field-hospital-20200403-duafjtk25vcjpi2ywdfqpd24le-story.html

Why Do We Learn About HVAC





Guide to the COVID-19 Pages

Follow the links on the Infographic

LEARN MORE

Core Recommendations for Reducing Airborne Infectious Aerosol Exposure

LEARN MORE

Questions Answered

Frequently Asked Questions and Glossary of Terms

FAQ / GLOSSARY

https://www.ashrae.org/technical-resources/resources

INTRODUCTION TO BUILDING HVAC SYSTEMS

Building HVAC Systems

- HVAC stands for Heating, Ventilation, and Air-Conditioning:
  - Heating: Boiler, furnace, heat pump, waste heat, heating coils
  - Ventilation: Outdoor air required for the spaces (e.g., ASHRAE 62.1)
  - Air-Conditioning: Chilled-water systems, cooling coils, Direct Expansion (DX) refrigerant systems

https://www.indiamart.com/proddetail/direct-expansion-cooling-coil-11707532291html & http://acscomfort.com/hvac-central-systems

Building HVAC Systems

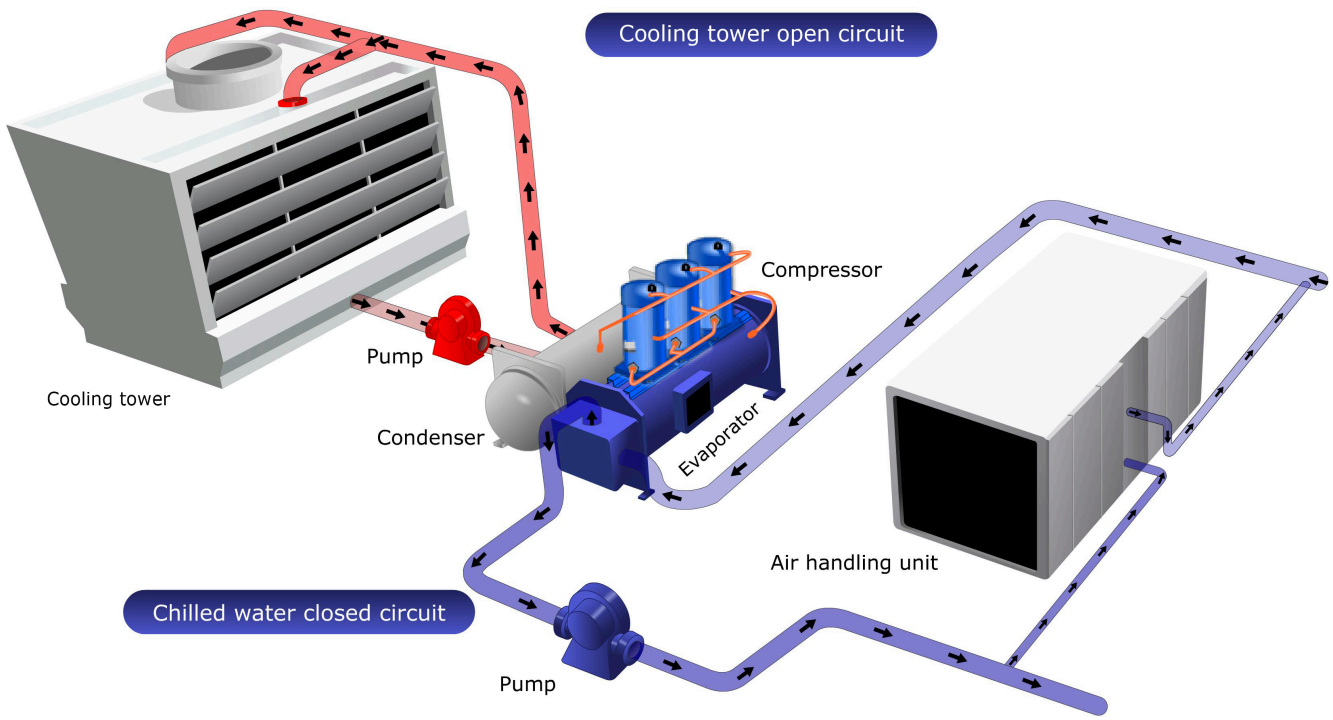
- Purpose of building HVAC systems is to control indoor air parameters within required:
  - ❑ Thermal comfort
  - ❑ Indoor air quality

Building HVAC Systems

- To achieve required indoor air parameters, the system needs to conduct one or more than one of the following heat transfer processes:
  - ❑ Heat
  - ❑ Cool
  - ❑ Humidify
  - ❑ Dehumidify
  - ❑ Filteration

Building HVAC Systems

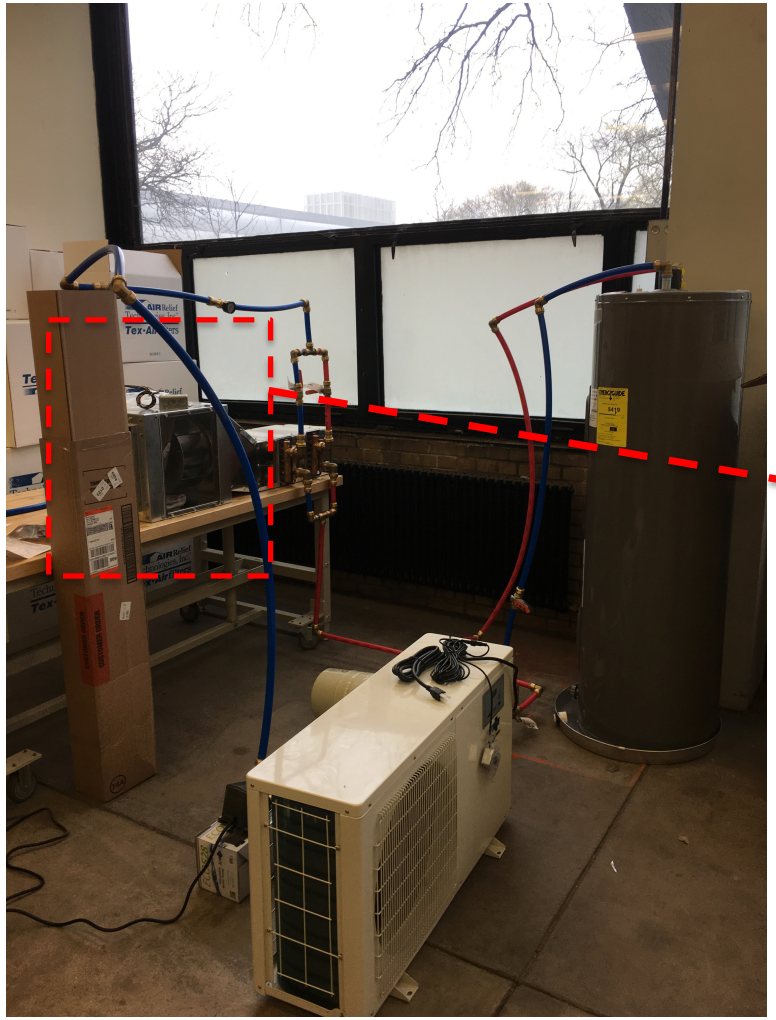
- Commercial HVAC system may include four main parts:
  - ❑ Primary systems or central plant
  - ❑ Distribution system
  - ❑ Terminal devices
  - ❑ Controls

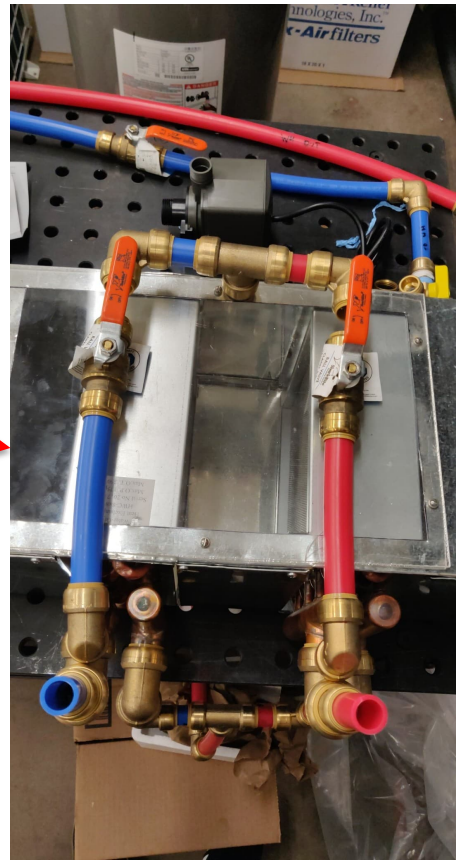


http://refrigerationandairconditioning.danfoss.us/applications/chillers/#/

Building HVAC Systems

- ASHRAE UG Equipment Lab (On-going)





Building HVAC Systems

- Primary systems are major energy consumers
  - In small buildings, we usually call them heating and cooling devices
  - In large buildings, we usually call them equipment and systems
- For large buildings sometimes they are called “plants” or “loops”
- Examples of a heating device is a boiler or furnace
- An example of a cooling system is a vapor compression

Building HVAC Systems

- Secondary systems distribute the cooling (or heating) produced by the primary systems (e.g., chillers or boilers) to the building spaces (e.g., specific rooms or thermal zones). Four types are:

  - ❑ All-water
  - ❑ All-air
  - ❑ Air-water systems
  - ❑ Refrigerant
  - ❑ Air-water-refrigerant
  - ❑ Air-refrigerant

What are the advantages and disadvantages of each type?

Building HVAC Systems

- Secondary system(s) may have different working fluids:

  - Hydronic systems (Water or steam)
    - Heat transfer to space by natural or forces convection
    - Only sensible load is met this way

  - Air systems (Air)
    - Both sensible and latent loads are met by a single supply air stream to each space
    - Deliver the required air ventilation
    - Require large volume of air

Building HVAC Systems

- Secondary systems entail:
  - ❑ Distribution system:
    - Ducts or pipes to carry working fluids
  - ❑ Equipment to compensate for pressure drop and move the working fluids:
    - Fans or pumps
  - ❑ Heat exchanger devices to transfer cool or heat from the working fluid to air:
    - Cooling or heating coils
  - ❑ Terminal devices to control, distribute, and deliver cooled or heated air to different zones:
    - Radiators, fan coils, room diffusers
  - ❑ Control devices to modulate the flow:
    - Temperature sensors, valves, dampers, thermostats

Building HVAC Systems

- Sources for primary energy for heating/cooling are:
  - ❑ Produced steam or hot water
  - ❑ Produced renewable electricity
  - ❑ Coal
  - ❑ Natural gas
  - ❑ Fuel oil
  - ❑ Biomass

https://www.alamy.com/water-panels-for-using-renewable-sun-energy-are-placed-on-house-roof-solar-hot-water-system-modern-energy-saving-technology-image221774114.html
http://www.riteboiler.com/index.php/products/hot-water-boilers/outdoor-atmospheric

Building HVAC Systems

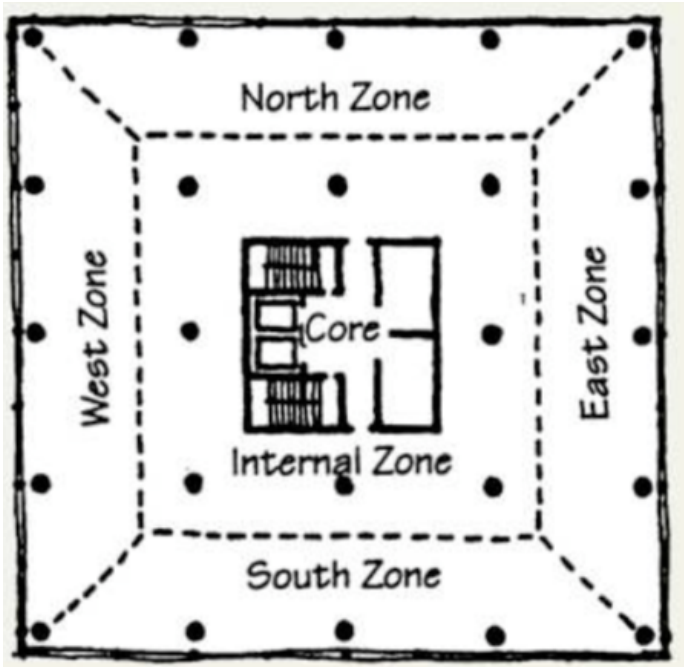
- Heating equipment, energy, distribution, and cycle options:
  - ❑ **Equipment:** Boiler, furnace, heat pump, electric resistance
  - ❑ **Energy:** Natural gas, oil, steam, electrical, renewable, waste heat
  - ❑ **Distribution:** Air, steam, water
  - ❑ **Cycle:** Vapor compression, combustion, renewable

Building HVAC Systems

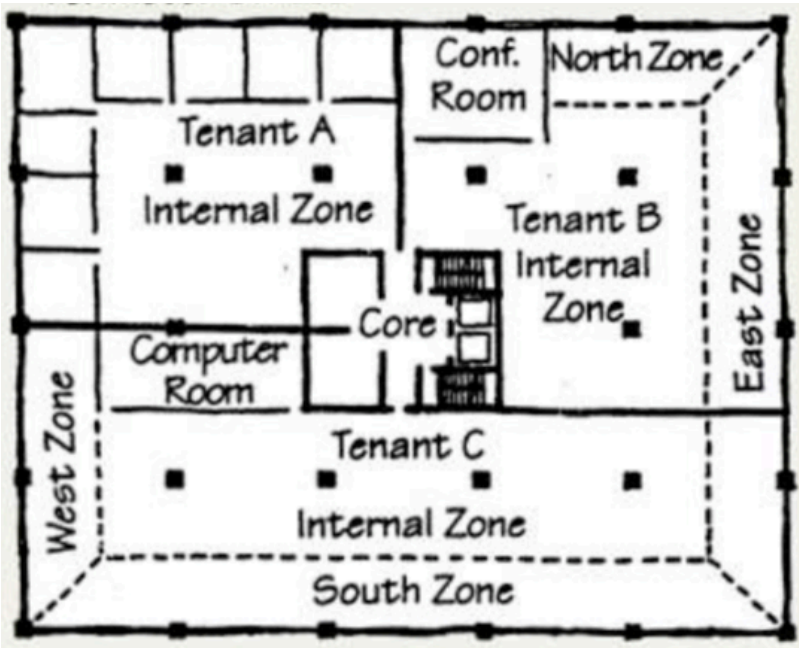
- Cooling equipment, energy, distribution, and cycle options:
  - ❑ **Equipment:** Air conditioner, chiller, heat pump
  - ❑ **Energy:** Electrical, natural gas, steam, waste heat, renewable
  - ❑ **Distribution:** Chilled water, air
  - ❑ **Cycle:** Vapor compression, absorption

Building HVAC Systems

- Thermal zone or zone:
  - ❑ Is a space or collection of spaces having similar space-conditioning requirements
  - ❑ Has the same heating and cooling setpoint



Based on orientation and floor



Based on spaces

Reddy et al. 2017

Building HVAC Systems

- Common ventilation types:

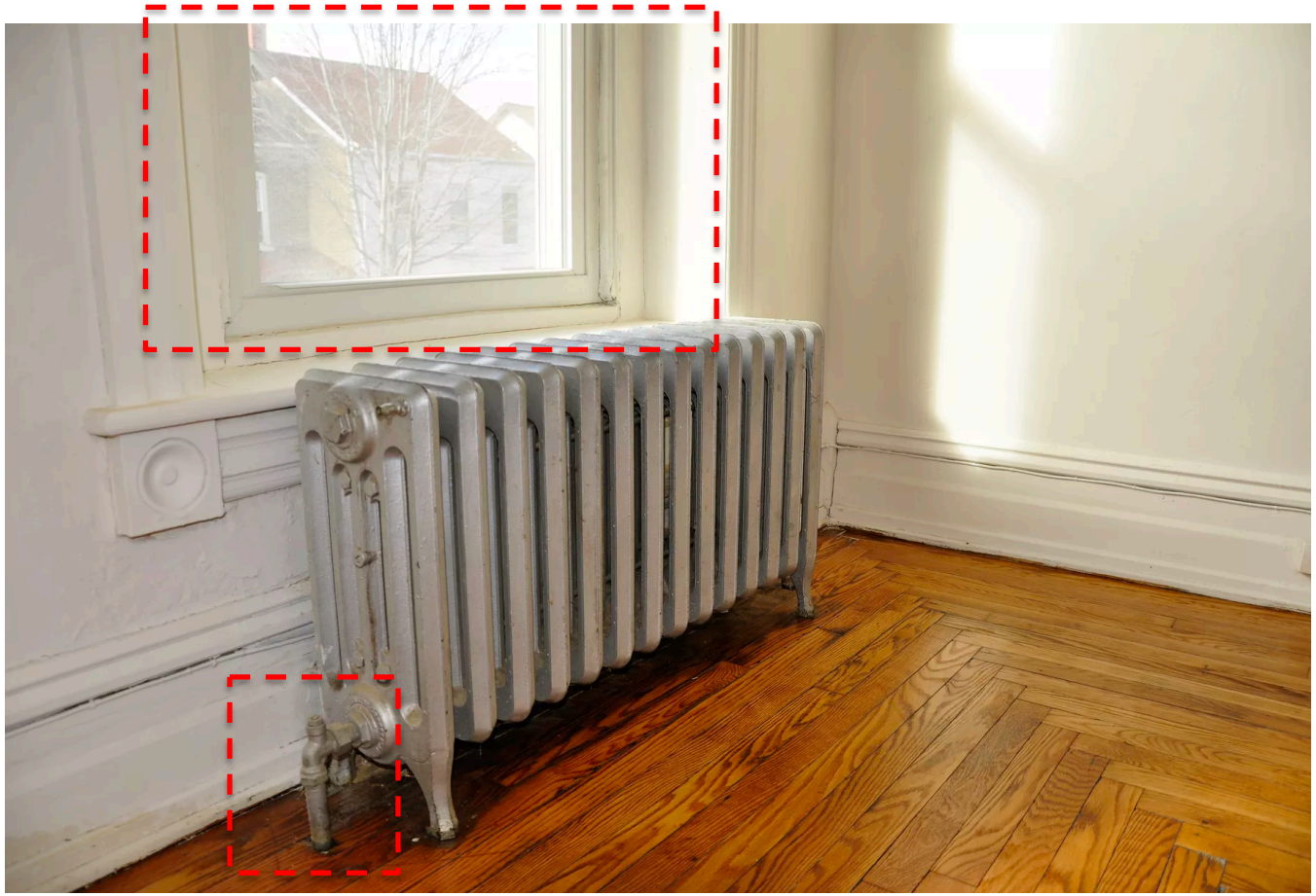
  - ❑ Constant Air Volume (CAV):
    - Hold the system airflow rate constant
    - Let the space thermostat modulate the supply air temperature

  - ❑ Variable Air Volume (VAV):
    - Modulate supply airflow rate
    - Hold the supply air inlet temperature constant

  - ❑ Dedicated Outdoor Air System (DOAS):
    - Consist of two parallel systems
    - Deliver outdoor to handle both latent and sensible loads
    - Include a parallel system to handle mostly sensible loads

Building HVAC Systems

- Can we have a system with no ventilation type?



Why do you think most of the radiators are located under the windows?

https://ny.curbed.com/2018/1/3/16845686/weather-nyc-311-heat-hot-water-complaint

Building HVAC Systems

- Strategies to understand the topics in this class is to identify:

  - ❑ System types:
    - Air distribution systems
    - Hydronic systems
    - Refrigeration systems

  - ❑ Energy sources

  - ❑ Primary and secondary

  - ❑ Ventilation types

ANNOUNCEMENTS

Announcement

- Summer Undergraduate Research Fellowship (SURF) Program at NIST
  - ❑ Projects: https://www.nist.gov/system/files/documents/2020/12/11/SURF%20Program%202021%20Projects.pdf
  - ❑ Job Posting: https://www.usajobs.gov/GetJob/ViewDetails/586814400

Project Description: The goal of this project is to develop elements of digital twin models for intelligent buildings. Digital twin models are software infrastructure to integrate best practices in computer science, such as knowledge representation, reasoning, machine learning techniques, with other engineering models (electrical, mechanical, architectural). The first step in this project involves developing a Building Information Model (BIM) of sample architectural drawings. The next step is to convert that BIM model to a semantic model using the existing well-established ontologies.

Announcement

- ASHRAE IL Chapter Scholarship
  - ❑ Application Link: https://illinoisashrae.org/Scholarship

Illinois Chapter of ASHRAE

Apply for Chapter Engineering Scholarships by January 31st

The deadline for Illinois Chapter ASHRAE Scholarships in 2021 is January 31st. The Illinois Chapter ASHRAE plans to award **up to four $1,500 scholarships** to deserving college students interested in pursuing studies in engineering, science or mathematics that are fundamental for a career in the HVAC field. **It's quick and simple to apply** for one of these scholarships. Applicants do not need to belong to an ASHRAE student chapter.

Don't let this opportunity to lower the educational expenses of the college student (and future engineer) in your life pass you by. **For additional information and (revised) application form, click here**.

Please submit your application by Jan. 31, 2021. The Chapter plans to announce scholarship winners in the spring of 2021.

Announcement

- Architectural Engineering Institute Scholarship 2021
  - ❑ Application Link: https://asceforms.wufoo.com/forms/m10janpz0zh58iu/

Please help distribute the following announcement about this year's AEI National Student Officers (NSOs) Scholarship to interested students to help foster engagement and involvement in AEI and to encourage further education and growth in the field. Due to the pandemic, this year's award will be as follows:

- Complimentary registration for the AEI 2021 Conference.
- Complimentary registration for the Workshop for Student Chapter Leaders.
- Exclusive one-on-one meeting with an architectural engineering industry professional.

Requirements:

1. Currently enrolled in an ABET/EAC accredited architectural engineering program.
2. An unofficial school transcript (in PDF format).
3. A recent copy of your resume (in PDF format).
4. List of activities related to involvement in your architectural engineering department (50 words or less).
5. Personal statement describing your involvement in your department, the architectural engineering field and AEI (500 words or less).
6. A letter of recommendation from a professor.

Who Can Apply?

All undergraduate and graduate level students who (1) intend to continue education in architectural engineering in the 2020-2021 academic year, and (2) are in good academic standing with their university of study, may apply for this scholarship.

Important Dates:

MARCH 1, 2021 (by 11:59 pm) | Deadline for submissions
MARCH 15, 2021 | Notification of award

Students may apply at: https://asceforms.wufoo.com/forms/m10janpz0zh58iu/.