

Location: Tempe COOR L1-20
Timing: Weekly Mon 6:00-8:45 pm

Muthukumar (Muthu) Ramalingam DN441 602-284-2913
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Herberger Institute for Design and the Arts

gjhildeb@asu.edu

SYLLABUS

CATALOG DESCRIPTION:

Architectural design implications of heating, ventilation, and air conditioning systems. This includes load calculation and system selection. Passive heating and cooling are also covered.

COURSE CONTENT:

The course covers the principles of natural science which affect the variables of human thermal comfort in the built environment. It then presents architectural strategies which can be used to control these variables. Emphasis is placed on using natural energies available in the local climate by proper use of the site and of architectural design elements. Calculation procedures on sizing of the selected architectural strategies are then explained.

In addition, it presents various systems that are used in buildings and its functions and selection. Emphasis is placed on HVAC system, and lighting systems for comfort. The goal is that the student will obtain an awareness of the architectural integration of building systems, and their implications on human comfort and the use of energy in buildings.

LEARNING OUTCOMES:

Students completing this course will be able to:

- Good understanding of the discipline of building science and its impact to the complete life cycle of buildings
- Design Energy conscious building
- Provide site and climate analysis
- Understand solar geometry and complete shading analysis
- Introduction to passive heating and cooling
- Read and understand mechanical plans
- Evaluate the output from MEP consultants
- Critically question the consultant of the alternative HVAC alternatives proposed
- Ask relevant questions about integration with other building systems when dealing with various consultants
- Design better buildings with multiple integrated systems

At the end of just this course, students will not be able to:

- Design HVAC systems
- Size HVAC equipment
- Become a Mechanical, Electrical, and Plumbing consultant

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COURSE ORGANIZATION:

The course is organized under the following headings:

1. Design Process
2. Climate, site, and resources
3. Solar geometry and solar control
4. Thermal comfort and psychrometrics
5. Heat flow and load calculations
6. Design strategies for passive heating and passive cooling
7. HVAC (Heating, Ventilating & Air Conditioning)

TEXT BOOK:

Grondzik, W. T., Kwok, A. G. (2015). *Mechanical and Electrical Equipment for Buildings* (12th Edition). New York: John Wiley & Sons, Inc. (aka MEEB)

SELECTED REFERENCES:

1. Baird, G. (2001). The architectural expression of environmental control systems. London: Spon Press.
2. Brown, G. Z., & DeKay, M. (2001). Sun, wind & light: Architectural design strategies. New York: Wiley.
3. Cook, J. (1989). Passive cooling. Cambridge, Mass: MIT Press.
4. Givoni, B. (1998). Climate considerations in building and urban design. New York: Van Nostrand Reinhold.
5. Hausladen, G. (2005). Climate design: Solutions for buildings that can do more with less technology. Basel, Switzerland: Birkhäuser.
6. Kwok, A. G., & Grondzik, W. T. (2011). Green studio handbook: Environmental strategies for schematic design. Oxford, UK: Architectural Press/Elsevier.
7. Mazria, E. (1979). The passive solar energy book. Emmaus, Pa: Rodale Press.
8. Moore, F. (1985). Concepts and practice of architectural daylighting. New York: Van Nostrand Reinhold.
9. Moore, F. (1993). Environmental control systems: Heating, cooling, lighting. New York: McGraw-Hill.
10. Olgyay, V., & Olgyay, A. (1992). Design with climate: Bioclimatic approach to architectural regionalism. New York: Van Nostrand Reinhold.
11. Santamouris, M. (2007). Advances in passive cooling. London: Earthscan.
12. Watson, D. (1979). Energy conservation through building design. New York: McGraw-Hill.

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13. Lechner, N. (2015) *Heating, Cooling, Lighting* (4th Edition). New Jersey: John Wiley & Sons
14. Pita, E. (2001) *Air Conditioning Principles and Systems* (4th Edition). London: Prentice-Hall
15. Jayamaha, L. (2007) *Energy-Efficient Building Systems*. New York: McGraw-Hill, Inc.
16. Rutkowski, H. (2005) *Psychrometrics, Theory and Applications, Manual P*. Air Conditioning Contractors of America.
17. Bradshaw, V. (2006) *The Building Environment* (3rd Edition). New Jersey: John Wiley & Sons
18. Grondzik, W. (2007) *Air Conditioning System Design Manual* (2nd Edition). Atlanta: ASHRAE
19. Bell, A. (2008) *HVAC Equations, Data, and Rules of Thumb* (2nd Edition). New York: McGraw-Hill, Inc.
20. Allen, E., Iano, J. (2012) *The Architect's Studio Companion: Rules of Thumb for Preliminary Design* (5th Edition). New Jersey: John Wiley & Sons
21. Ching, F., Winkel, S. (2012) *Building Codes Illustrated: A Guide to Understanding the 2012 International Building Code* (4th Edition). New Jersey: John Wiley & Sons
22. Egan, M. D. (2001) *Architectural Lighting*. New York: McGraw-Hill, Inc.
23. Ander, G. (2003) *Daylighting Performance and Design*. New York: John Wiley & Sons
24. Egan, M. D. (1988). *Architectural Acoustics*. New York: McGraw-Hill, Inc.
25. ASHRAE (Any recent edition) *ASHRAE Handbook of Fundamentals*. Atlanta: ASHRAE

SELECTED WEBSITES:

<http://www.energy-design-tools.aud.ucla.edu/>
<http://sefaira.com/>
<http://www.doe2.com/>
<http://web.utk.edu/~archinfo/EcoDesign/swl/index.html>
<http://vitalsigns.ced.berkeley.edu/>
<http://www2.buildinggreen.com/>
<http://www.usgbc.org/projects>
<http://www.ukgbc.org/content/case-studies>
<http://www.gbca.org.au/green-star/green-building-case-studies/>
<http://www.2030palette.org/>
<http://www.wbdg.org/>
<http://solardat.uoregon.edu/>

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<http://www.architecture2030.org/>

<http://network.aia.org/committeeontheenvironment/home/>

<http://www.aia.org/practicing/groups/kc/AIAS077430>

INSTRUCTIONAL METHODS:

Instruction will rely on lectures, frequent quizzes, reading assignments, class discussions, assigned exercises, a field trip, a mid-term exam and a final exam.

COURSE GRADING:

ASU's +/- grading (see scale below) will be used:

A-/ A	90-94/94-100%	Excellent
B- /B/ B+	80-84/ 84-87/ 87-90%	Good
C/ C+	70-76/ 77-80%	Average
D	60-70%	Passing
E	0-60%	Failure
XE		Failure due to Academic Dishonesty

The final course grade will be assigned on the basis of the following categories and according to the following weights:

	Percent Weight
Quiz.....	25
Assignment	25
Exercise.....	10
Final Exam	25
Attendance	15
	100

The requirements for specific Assignments will be posted on Canvas.

OFFICE HOURS:

Office hours will be held by the instructor in room DN 441 by appointment. TA will be available in room DN 441 for office hours on Wednesdays from 12:00 – 1:00 PM.

COURSE REQUIREMENTS:

Canvas:

The class notes will be posted electronically on Canvas. Assignments, discussions, and grades will be posted on the Canvas site. Students are expected to check the Canvas at least once every 2 days.

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Attendance:

Attendance is required. If an absence is necessary it should be discussed with the instructor prior to the class date. Each day of attendance will give you one point, excused absences will give you half point and unexcused absences will result in 0 point.

Exercise:

Every week, there will be some hands on activity using worksheets. Required worksheets will be posted before the class on Canvas. Please bring printed worksheet related material to the class for this activity.

Assignments:

All assigned homework must be completed. Assignments will be accepted up to a week late with a reduction one letter grade from the grade that would have been given if it was submitted on time. Assignments that are late by more than a week will not be accepted. All assignments, unless otherwise announced by the instructor, must be submitted via Canvas. Each assignment will have a designated place to submit on the Canvas.

Quiz:

Quiz will be given pretty much at the beginning of each class (see schedule). Excused absentees can submit a make-up assignment to substitute for Quiz points.

Attendance Policy:

Attendance will be taken every class in the form of signup sheet or through quiz participation. It is expected that a student attends each and every class unless advised otherwise. Attendance could be excused with a doctor's note and that allows the student make-up assignment/quiz up to 1 week late after returning. Excused absences related to religious observances/practices that are in accord with [ACD 304-04, Accommodation for Religious Practices](#); and Excused absences related to university sanctioned events/activities that are in accord with [ACD 304-02, Missed Classes Due to University-Sanctioned Activities](#).

Subject to Change Notice:

All material, assignments, and deadlines are subject to change with prior notice. It is your responsibility to stay in touch with your instructor, review the course site regularly, or communicate with other students, to adjust as needed if assignments or due dates change.

Drop and Add Dates:

If you feel it is necessary to withdraw from the course, please see <http://students.asu.edu/drop-add> for full details on the types of withdrawals that are available and their procedures.

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STUDENT CONDUCT STATEMENT:

Students are required to adhere to the ASU Student Academic Integrity Policy

(<http://www.asu.edu/studentaffairs/studentlife/srr/index.htm>).

Students are entitled to receive instruction free from interference by other members of the class.

If a student is disruptive, an instructor may ask the student to stop the disruptive behavior and warn the student that such disruptive behavior can result in withdrawal from the course. An instructor may withdraw a student from a course when the student's behavior disrupts the educational process under USI 201-10 (<http://www.asu.edu/aad/manuals/usi/usi201-10.html>).

Courtesy and Respect:

Please refrain from personal conversations with your classmates or on the phone during class. Side conversations are disruptive, disrespectful and discourteous.

Academic Dishonesty:

All necessary and appropriate sanctions will be issued to all parties involved with plagiarizing any and all course work. Plagiarism and any other form of academic dishonesty that is in violation with the Student Code of Conduct will not be tolerated. For more information, please see the ASU Student Academic Integrity Policy:

http://www.asu.edu/studentaffairs/studentlife/judicial/academic_integrity.htm

Harassment (Title IX):

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at <https://sexualviolenceprevention.asu.edu/faqs>.

As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, <https://eoss.asu.edu/counseling>, is available if you wish discuss any concerns confidentially and privately.

SYLLABUS DISCLAIMER:

The instructor views the course syllabus as an educational contract between the instructor and students. Every effort will be made to avoid changing the course schedule but the possibility exists that unforeseen events will make syllabus changes necessary. The instructor reserves the right to make changes to the syllabus as deemed necessary. Students will be notified in a timely

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manner of any syllabus changes face to-face, via email or in the course site announcements. Please remember to check your ASU email and the course site announcements often.

TECHNICAL SUPPORT:

For technical assistance 24 / 7, please contact the University Technology Office Help Desk:

Phone: 480-965-6500; web: <http://help.asu.edu/> ; email: helpdesk@asu.edu

ACCESSIBILITY STATEMENT:

Students who wish to request an accommodation for a disability should contact the Disability Resource Center (DRC): Phone: 480-965-1234; web: <http://www.asu.edu/studentaffairs/ed/drc/>; email: DRC@asu.edu

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EXPECTED COURSE SCHEDULE:

Wk	Date	Topic	Exercise	Quiz	Assign	Read (MEEB)
1	7-Jan	Class orientation				
2	14-Jan	Central Plan Tour (different timing than class)				
3	21-Jan	NO CLASS (MLK Day)				
4	28-Jan	Design process, Climate, site analysis	Climate analysis		Y	Ch 1,2, 4.2
5	4-Feb	Pyschrometrics	Pychrometrics calculations	Y	Y	Ch 4.2
6	11-Feb	Thermal comfort, solar angles	Solar angles calculation	Y	Y	Ch 4.3
7	18-Feb	Shading and building examples	Shading calculation	Y	Y	Ch 6
8	25-Feb	Load calculation for opaque surfaces	Load calculation	Y	Y	Ch 7.1-7.4
9	4-Mar	SPRING BREAK				
10	11-Mar	Load calculation (Transparent surfaces, Mass flow, internal load)	Load calculation	Y	Y	Ch 7.5-7.10
11	18-Mar	Passive cooling with examples	Passive cooling calculation	Y	Y	Ch 9
12	25-Mar	Passive heating with examples	Passive heating calculation	Y	Y	Ch 10
13	1-Apr	HVAC system taxonomy & Principle	HVAC design thumb rules	Y	Y	Ch 12.1-15
14	8-Apr	HVAC systems and components	Zoning	Y	Y	Ch 12.15-20
15	15-Apr	System selection, All air/All water/Air-water system	System selection	Y	Y	
16	22-Apr	Putting it together, distribution system	Overall HVAC design	Y		
17	29-Apr	Final Exam (Closed book)				

This course schedule may be subject to change.