

Advanced Refrigeration

EML 5605 Sections 1FE2, 2FED, CAMP, and HYBR

EML 4930 Sections AR01 and AR02

Class Periods: MWF, 8th period, 3:00-3:50pm (**view recorded lectures**)

Location: NEB 201

Academic Term: Fall 2020

Instructor:

Dr. SA Sherif, Professor

Department of Mechanical and Aerospace Engineering

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<https://faculty.eng.ufl.edu/sa-sherif/>

Office Hours via Zoom: MWF 3:00-4:00pm **for this class**

Teaching Assistants: None

Course Description

Analysis and design considerations for vapor compression, absorption, steam-jet, thermoelectric, and air refrigeration systems, 3 Credits.

Course Pre-Requisites/Co-Requisites: Graduate standing or permission of instructor

Course Objectives

Students will be able to analyze and design all types of refrigeration systems including vapor compression, vapor absorption, steam jet, thermoelectric, thermoacoustic, magnetic, and air refrigeration systems. Students will also be able to perform design calculations on refrigeration system components including air and water cooled condensers, flooded and dry-out evaporators, compressors of all types including reciprocating, centrifugal, screw, rotary-vane, and other compressor types, and metering and control devices including expansion valves and capillary tubes. Students will also be able to analyze and design liquid recirculation systems and perform refrigeration load calculations.

Materials and Supply Fees: None

Required Textbooks and Software: A series of handouts

Recommended Materials

1. *Modern Refrigerating Machines*, by I. Cerepnalkovski, Elsevier Science Publishers, Amsterdam, The Netherlands, 1991.
2. *Thermal Environmental Engineering*, Third Edition, by T.H. Kuehn, J.W. Ramsey, and J.L. Threlkeld. Prentice-Hall, Inc., Englewood Cliffs, NJ, 1998
3. *ASHRAE 2017 Handbook - Fundamentals*, ASHRAE, Inc., 1791 Tullie Circle, N.E., Atlanta, Georgia 30329.
3. Absorption Chillers and Heat Pumps, K.E. Herold, R. Radermacher, and S.A. Klein, CRC Press, Boca Raton, Florida, 1996.
3. *Industrial Refrigeration*, by W.F. Stoecker, Business News Publishing Co., Troy, Michigan, 1988.
4. *Industrial Refrigeration*, Volume II, by W.F. Stoecker, Business News Publishing Co., Troy, Michigan. 1995.
5. *ASHRAE 2018 Handbook - Refrigeration*, ASHRAE, Inc., Atlanta, Georgia, 2018.
6. Heat Conversion Systems, by G. Alefeld and R. Radermacher, CRC Press, Inc., Boca Raton, Florida, 1993.
7. *Refrigeration and Air Conditioning*, by W.F. Stoecker and J.W. Jones, McGraw-Hill, Inc., New York, 1986
8. *Entropy Generation Minimization*, by A. Bejan, CRC Press, Inc., Boca Raton, FL, 1996.

Subjects

1. Fundamental Theory of Refrigeration Cycles
2. Classification of Refrigerants (Types, Numbering System)
3. Single-Stage Vapor Compression Refrigeration Systems
4. Mechanical Vapor Compression Components and Systems
 - a. Refrigeration Compressors (Reciprocating, Centrifugal, Screw, Vane, Rolling Piston)
 - b. Condensers (Shell-and-Tube, Fin-and-Tube, Plate)
 - c. Evaporators (Flooded, Dry-Out, Direct Expansion)
 - d. Expansion Devices (Throttle Valves, Capillary Tubes)
5. Complex and Multi-Stage Vapor Compression Refrigeration Systems
6. Liquid Recirculation Systems

7. Valves and Refrigerant Controls
9. Absorption Refrigeration Systems
 - a. Absorption Cycle Fundamentals
 - b. Properties of Working Fluids
 - c. Thermodynamic Processes with Mixtures
 - d. Overview of Water/Lithium-Bromide Technology
 - e. Single-Effect Water/Lithium-Bromide Systems
 - f. Multiple-Effect Water/Lithium Bromide Systems
 - g. Single-Stage Ammonia/Water Systems
 - h. Multi-Stage Ammonia/Water Systems
10. Air Compression Refrigeration Systems
11. Steam-Jet and Jet-Ejector Refrigeration Systems
12. Thermoelectric Refrigeration
13. Flash Cooling
14. Thermoacoustic Refrigeration
15. Magnetic Refrigeration
16. Refrigeration Load Calculations

Attendance Policy, Class Expectations, and Make-Up Policy

Watching the video lectures online is a necessary condition but it is not a sufficient one to be able to do well in this class. It is expected that 3 to 5 study hours for each contact hour are to be spent every week studying for this class. If a week is missed, the study hours need to be made up in the following weeks. Homework problems will be assigned via Canvas and submitted through Canvas. **No email or hard copy submissions will be accepted.** You may upload homework assignments early, but not past the due date. The assignments will be due at 11:59pm on the due date. After that, the system will stop accepting the assignments. Late homework is not accepted via any other means. **I am available 24/7 via 352-392-7821 or sasherif@ufl.edu**

<u>Lecture #</u>	<u>Topic Covered</u>	<u>Lecture #</u>	<u>Topic Covered</u>
Lecture 1	Fundamentals of refrigeration theory 1	Lecture 29	Evaporators (analysis/design) 2
Lecture 2	Fundamentals of refrigeration theory 2	Lecture 30	Evaporators (analysis/design) 3
Lecture 3	Refrigerants 1	Lecture 31	Evaporators (analysis/design) 4
Lecture 4	Refrigerants 2	Lecture 32	Evaporators (analysis/design) 5
Lecture 5	Vapor compression refrigeration cycle 1	Lecture 33	Evaporators (analysis/design) 6
Lecture 6	Vapor compression refrigeration cycle 2	Lecture 34	Evaporators (analysis/design) 7
Lecture 7	Compressors (analysis/design) 1	Lecture 35	Absorption refrigeration 1
Lecture 8	Compressors (analysis/design) 2	Lecture 36	Absorption refrigeration 2
Lecture 9	Compressors (analysis/design) 3	Lecture 37	Absorption refrigeration 3
Lecture 10	Compressors (analysis/design) 4	Lecture 38	Absorption refrigeration 4
Lecture 11	Compressors (analysis/design) 5	Lecture 39	Absorption refrigeration 5
Lecture 12	Compressors (analysis/design) 6	Lecture 40	Absorption refrigeration 6
Lecture 13	Compressors (analysis/design) 7	Lecture 41	Absorption refrigeration 7
Lecture 14	Condensers (analysis/design) 1	Lecture 42	Absorption refrigeration 8
Lecture 15	Condensers (analysis/design) 2	Lecture 43	Multistage vapor compression refrigeration systems
Lecture 16	Condensers (analysis/design) 3	Lecture 44	Thermoelectric refrigeration systems 1
Lecture 17	Condensers (analysis/design) 4	Lecture 45	Thermoelectric refrigeration systems 2
Lecture 18	Condensers (analysis/design) 5	Lecture 46	Flash cooling/steam-jet refrigeration/air refrigeration
Lecture 19	Condensers (analysis/design) 6	Lecture 47	Thermoacoustic refrigeration/magnetic refrigeration
Lecture 20	Condensers (analysis/design) 7	Lecture 48	Liquid recirculation systems
Lecture 21	Condensers (analysis/design) 8	Lecture 49	Expansion devices (capillary tube design) 1
Lecture 22	Condensers (analysis/design) 9	Lecture 50	Expansion devices (capillary tube design) 2
Lecture 23	Condensers (analysis/design) 10	Lecture 51	Expansion devices (expansion valves)
Lecture 24	Condensers (analysis/design) 11	Lecture 52	Refrigeration load calculations (cooler)
Lecture 25	Condensers (analysis/design) 12	Lecture 53	Refrigeration load calculations (cooler)
Lecture 26	Condensers (analysis/design) 13	Lecture 54	Refrigeration load calculations (cooler/freezer)
Lecture 27	Condensers (analysis/design) 14	Lecture 55	Refrigeration load calculations (freezer)
Lecture 28	Evaporators (analysis/design) 1		

Evaluation of Grades

Exam 1 (take-home covering Lectures 1 through 34), released October 28, 2020	50%
Exam 2 (take-home covering Lectures 28 through 55), released December 2, 2020	50%
HW Assignments	-3% of the course grade per missed assignment

Grading Policy

Percent	Grade	Grade Points
92.0 - 100.0	A	4.00
88.0 - 92.00	A-	3.67
84.0 - 88.0	B+	3.33
80.0 – 84.0	B	3.00
76.0 - 80.0	B-	2.67
72.0 - 76.0	C+	2.33
68.0 – 72.0	C	2.00
64.0 - 68.0	C-	1.67
60.0 - 64.0	D+	1.33
56.0 - 60.0	D	1.00
50.0 - 56.0	D-	0.67
0 - 50.0	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

Campus Resources:
Health and Wellness

U Matter, We Care:

If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.