MAE 695: Special Topics, Conduction and Diffusion
Fall Semester 2013
Syllabus

Instructor: Dr. George J. Nelson, Assistant Professor, Mechanical and Aerospace Engineering

Office: Technology Hall N259 **Office Hours:** TR 2:00 p.m.-3:00 p.m. and by appointment

Phone: 256-824-5082 **E-mail:** george.nelson@uah.edu

Lecture: TR 5:30 p.m.-6:50 p.m., Madison Hall, Room 207

Course Description: Thermal conduction and mass diffusion are addressed, and common characteristics and modeling approaches are discussed. Topics covered will include analytical methods for conduction heat transfer and analogous diffusion mass transfer problems, fundamentals of diffusion, multicomponent diffusion, diffusion in porous media, and diffusion in the presence of chemical reactions. Connections will be drawn between diffusive transport phenomena and the performance of energy storage and conversion devices, including fuel cells and batteries.

Course Objective: The goal of this course is to introduce mechanical engineers to the fundamental concepts of heat conduction and mass diffusion and to illustrate these concepts within the context of current engineering research in the area of energy storage and conversion.

Textbook: M. C. Wendl, *Theoretical Foundations of Conduction and Convection Heat Transfer*: The Wendl Foundation, 2012.
E. L. Cussler, *Diffusion: Mass Transfer in Fluid Systems*, Third Edition: Cambridge University Press, 2009.
Selected readings from the literature made available through course reserves.

Deliverables and Evaluation:
Homework: 10% of Final Grade
Literature Review: 10% of Final Grade
Semester Project: 25% of Final Grade
Midterm Exam: 25% of Final Grade
Final Exam: 30% of Final Grade

Homework: Problems sets covering course materials will be assigned throughout the semester.

Literature Review: Each student will provide a five page literature review addressing a problem involving heat conduction or mass diffusion that is relevant to current engineering research in the field of energy systems. This review will establish the basis for the semester project.

Semester Project: Using analytical solutions, numerical methods, or a combination thereof each student will complete an analysis relevant to the problem presented by the literature review.

Exams: Midterm and final exams will be comprised of problems covering physical fundamentals addressed in class and short conceptual questions.

Attendance Policy: Students are responsible for all material addressed in the lecture notes, in class discussion, and the suggested readings. Attendance and participation are strongly suggested. *Rescheduling of exams will be accommodated in accordance with University policy and in certain limited cases. Rescheduling an exam should be arranged with the course instructor well in advance of the exam date.* In the case of extenuating circumstances written documentation justifying the absence will be required. Examples include, but are not limited to, a note from a medical professional for an illness and an accident report from a law enforcement official.

Disabilities: The University of Alabama in Huntsville will make reasonable accommodations for students with documented disabilities. If you need support or assistance because of a disability, you may be eligible for academic accommodations. Students should identify themselves to the Disability Support Services Office (256-824-1997 or Madison Hall, room 131) and their instructor as soon as possible to coordinate accommodations.

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Planned Course Schedule

Session	Date	Topic	Related Reading
1	8/22	Introduction	Wendl: 1.1-2.2
2	8/27	The Conduction Heat Equation	Wendl: 2.3-2.6
3	8/29	1-D Steady-State Conduction: Fins	Wendl: 3.1-3.4
4	9/3	1-D Steady-State Conduction: Fins	Wendl: 3.5-3.8
5	9/5	2-D Steady-State Conduction: Separation of Variables	Wendl: 5.1 & 5.3
6	9/10	2-D Steady-State Conduction: Separation of Variables	Wendl: 5.4
7	9/12	Non-Homogeneous Problems and Superposition	Wendl: 5.5-5.8
8	9/17	Non-Homogeneous Problems and Superposition	Wendl: 5.5-5.8
9	9/19	1-D Transient Conduction	Wendl: 4.1-4.3
10	9/24	1-D Transient Conduction	Wendl: 4.4-4.5
11	9/26	Semi-Infinite Solids: Similarity Solutions	Wendl: 4.6
12	10/1	Semi-Infinite Solids: Similarity Solutions	Wendl: 4.6
	10/3	**Fall Break**	
13	10/8	Moving-Boundary Problems	TBD
14	10/10	Nanoscale Considerations	TBD
15	10/15	Nanoscale Considerations	TBD
16	10/17	**Midterm Exam**	
17	10/22	Diffusion Fundamentals: Diliute Solution Theory	Cussler: 1.1-2.4
18	10/24	Diffusion Fundamentals: Concentrated Solution Theory	Cussler: 3.1-3.2
19	10/29	Diffusion Fundamentals: Concentrated Solution Theory	Cussler: 3.3-3.5
20	10/31	Diffusion Coefficients in Gases and Liquids	Cussler: 5.1-5.2
21	11/5	Multicomponent Diffusion and Porous Media	Cussler: 6.4, 7.1-7.3
22	11/7	The Dusty-Gas Model: Background	TBD
23	11/12	The Dusty-Gas Model: Diffusion in Fuel Cell Components	TBD
24	11/14	Diffusion with Heterogeneous Reactions	Cussler: 16.1-16.3
25	11/19	Shrinking Core Models: Background	Cussler: 16.4
26	11/21	Shrinking Core Models: Li-Ion Battery Charge & Discharge	TBD
27	11/26	Diffusion with Homogeneous Reactions	Cussler: 17.1-17.2
	11/28	**Thanksgiving**	
28	12/3	Extended Surface Models in Electrochemistry	TBD
29	12/5	**Final Exam, 6:30-9:00 p.m., Lecture Room**	