Spring 2015
Convection Heat Transfer
MECH-7091-001

Instructor

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Office Hours: Immediately following class and by appointment.

Textbook

Convection Heat Transfer, Adrian Bejan, Wiley & Sons, Inc., 4th Edition, 2013.
(Select chapters are posted on BB)

References:

1. Convective Heat and Mass Transfer, W. M. Kays and Crawford, McGraw-Hill, 4th Edition, 2005.
2. Introduction to Convective Heat Transfer Analysis, P. Oosthuizen and D. Naylor, McGraw-Hill, 1999.
3. Convective Heat Transfer, S. Kakac and Y. Yener, CRC Press, 2nd Edition, 1995.
4. Convective Heat Transfer, L. C. Burmeister, Wiley, 1983.
5. Convection Heat Transfer, V. S. Arpaci and Larsen, Prentice-Hall, 1984.

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1. Handbook of Single-Phase Convective Heat Transfer, Edited by Kakac, Shah, and Aung, Wiley, 1987.
2. Handbook of Heat Transfer, Edited by Rohsenow, Hartnett, and Cho, McGraw-Hill, 3rd Edition, 1998.
3. Laminar Flow Forced Convection in Ducts, R. K. Shah and A. L. London, Advances in Heat Transfer, Supplement 1 Academic Press, 1978.
4. Convection in Porous Media, D.A. Nield and Adrian Bejan, Springer-Verlag, 1992.
5. Physical & Computational Aspects of Convective Heat Transfer, Cebeci & Bradshaw, Springer-Verlag, 1984.

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1. **Fund. of Heat & Mass Transfer, Bergman, Lavine, Incropera & DeWitt, Wiley, 7th Edition, 2011.**
2. Heat Transfer, Adrian Bejan, Wiley & Sons, Inc., 1993.
3. Heat Transfer - A Basic Approach, M. N. Ozisik, McGraw-Hill, 1985.

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1. Viscous Fluid Flow, F. M. White, McGraw-Hill, 3rd Edition, 2006.
2. Incompressible Flow, R. L. Panton, Wiley, 3rd Edition, 2005.
3. Boundary Layer Theory, H. Schlichting, McGraw-Hill, Seventh Edition, 1979.

Objectives This is a "core" course for any graduate student majoring in the thermal science field. Through a series of homework problems and project/tests, the student will gain an in-depth, theoretical, working knowledge of **laminar incompressible forced convective heat transfer.** Topics studied include both **laminar external** and **laminar internal** fluid flow problems. Also external natural convection and convection in porous medium will also be covered but to a limited extent. (Note convection with *turbulent* flow is not covered in this course but is the main subject topic for MECH-8092, Advanced Convection Heat Transfer.)

Prerequisites Undergraduate heat transfer and fluid mechanics. Viscous Flow will be extremely helpful, but not absolutely necessary (i.e. I'll summarize what is needed). Some basic knowledge with ordinary differential equations and partial differential equations. Only very elementary numerical analysis and computer programming.

Class Notes Please be aware that a fairly complete (> 95%) set of class notes / lectures is already posted on BB to help with note taking and to eliminate handouts reproduction. However, please note, that as we go along though the course this semester, I will be updating / revising / expanding some of my lecture notes as necessary.

Grading System *(tentative)*

Homework	20 %
Test I or Project I (forced external flow)	30 %
Test II or Project II (forced internal flow)	30 %
Test III or Project III (from topic IV, maybe)	20 %

Tests / Projects

Besides the assigned HW, there will be two tests to take, **or** two projects to complete **(or some combination thereof),** which will focus on the two different areas of convection heat transfer. The first topic will focus on solving the laminar boundary layer equations (external flow B.L. type convection problem) using the similarity solution methodology. The second area will involve solving the differential thermal energy equation for laminar fully-developed or developing internal channel flow geometry. Sample computer codes (if appropriate) will be provided to help solve the particular problem of interest for the given project, but must be slightly modified by the students. Numerical problems can be easily solved on CEAS computer system or on a personal computer.

	TOPICS	**(Bejan's) CHAPTERS**
I.	Differential Equations & Background Information Introduction, review of Navier-Stokes, derivation of differential thermal energy equation, general solution methodology, problem classification, nondimensionalization.	1
II.	External Laminar Forced Convection Boundary layer equations, similarity solutions and shooting methods, wedge flow problem.	2
	TEST I or PROJECT I (1st MIDTERM)	
III.	Internal Laminar Forced Convection Fully developed laminar duct flow, developing channel flow - Graetz problem, combined problem.	3
	TEST II or PROJECT II (2nd MIDTERM)	
IV.	Additional Topics – *(as time permits)* External Natural Convection, (B.L. with fixed T and heat flux B.C.) Convection in Porous Media, (forced F.D. channel flow, external B.L.)	 4 12
	TEST III or PROJECT III (Maybe)	

In short, we will cover in detail the first three chapters of the textbook. In addition we will also cover, but in less depth, laminar external natural convection and convection in porous media.

Topics Not Covered: convection with *turbulent* flow, computational and experimental convection