EML 6155 - Convection Heat Transfer – Spring 2021

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Class Hours and Location:
M W F, 1:55 PM to 2:45 PM
Location: 100% Virtual & 1% in-class instruction for NEW international students (time will be announced)
All lectures are pre-recorded and available on the course website (https://ufl.instructure.com/courses/418794) under Course Lecture Videos.
Please see Appendix A of this document for lectures numbers and dates.

Virtual Office Hours:
Monday: 2:45 PM to 3:55 PM
Wednesday: 2:45 PM to 3:55 PM
Friday: 2:45 PM to 3:55 PM

Teaching Assistant:
TBA

Books:
1- Text: Convective Heat and Mass Transfer by W. M. Kays et al., 4th Ed., McGraw-Hill, 2009
2- Text: Convection Heat Transfer by A. Bejan, 3rd Ed., John Wiley & Sons, 2004
3- Convective Heat Transfer by Burmeister, 2nd Ed., John Wiley & Sons, 1993
4- Boundary Layer Theory by Schlichting, 7th Ed., McGraw-Hill, 1979

Course Objective: to provide a fundamental treatment of fluid flows controlled by viscous or turbulent stress gradients and the subsequent heat transfer between fluids and solid surfaces. Analytical solutions to the momentum and energy conservation equations for both laminar and turbulent flows will be considered. Students will be expected to derive appropriate transport equations, apply transport equations to convective transport problems, and evaluate appropriate transport properties such as friction factors, Nusselt numbers, Sherwood numbers, and Stanton numbers. The fundamental conservation principles covered in this course provide a solid foundation for the engineering practitioner engaged in single phase convective thermal transport; a solid foundation is also provided for further studies in multiphase convective transport.

Course Outline:
1. Introduction
2. Fundamental principles
    a. Mass conservation

   b. Force balances (Momentum equations)
   c. Energy equations
   d. A simple case: Couette flow
   e. Scale analysis
3. Laminar boundary layer flow
   a. The fundamental problem in convection heat transfer
   b. The concept of boundary layer
   c. Velocity and thermal boundary layer thicknesses
4. Laminar momentum and heat transfer in ducts
   a. Entry region
   b. Fully developed flow
   c. Flow and heat transfer in circular and non-circular cross-section ducts
   d. Nusselt number at different wall thermal conditions
5. Laminar momentum and heat transfer in external boundary layers
   a. Potential flow solutions to velocity field
   b. Self similar boundary layers
   c. Similarity transformations
   d. Flow over a flat plate solutions
   e. Displacement thickness, momentum thickness
   f. Integral momentum equation and approximate solutions
   g. Thermal boundary layer similarity transformation and solution
   h. Integral energy equation and approximate solutions
6. Natural convection boundary layers
   a. Boundary layer equations
   b. Boussinesq approximation
   c. Nusslet number (laminar flow)
7. Turbulence fundamentals
   a. Transition to turbulent
   b. Reynolds decomposition
   c. Averaging properties
   d. Turbulent (Reynolds) stress and turbulent (eddy) thermal diffusivity
   e. Prandtl mixing length model
   f. Turbulent Prandtl number
8. Turbulent fluid flow
   a. Law of the wall
   b. Universal velocity profile for external flow
   c. Friction coefficient
   d. Internal flow
9. Turbulent thermal transport
   a. External flow
   b. Law of the wall
   c. Internal flow

Grading:

1. Grading Basis:
   Homework 15%

Mid-term Exam I	25%
Mid-term Exam II	25%
Final Exam	35%
Total	100%

2. Homework: Homework assignments weekly to biweekly.
   Show all work, mark all answers, and be neat.
   Online submission https://ufl.instructure.com/courses/418794

3. Exams:
   Exam I: Wednesday, February 17th, 5:300pm to 7:30pm
   Exam II: Wednesday, March 26th, 5:30pm to 7:30pm
   Final Exam (comprehensive): Thursday, April 29th, 9:30am to 12:30pm

   No make-up exams will be given unless there is a valid reason consistent with University policy.

4. Grading scale:
   A curve will be applied to all exams to bring the class average to 85/100. The letter grade will be based on the 10-point scale (i.e. A ≥ 90%, B+ ≥ 85%, B ≥ 80%, C+ ≥ 75%, and C ≥ 70%).

Holidays:

UF Recognized Holidays (no class):
Monday, January 18th (Martin Luther King Jr. Day)

Recharge Days (no class):

February 25th
March 24th

Class Policies:

1. All homework assignments and bonus problems are to be turned by midnight of the due day.

2. SOME collaboration is allowable on homework, but each student is responsible for performing the bulk of his or her own homework assignment.

3. NO collaboration is allowed on exams.

Academic Honesty:

All students admitted to the University of Florida have signed a statement of academic honesty committing them to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action.
This statement is a reminder to uphold your obligation as a student at the University of Florida and to be honest in all work submitted and exams taken in this class and all others.

Appendix A

Lecture Date	Video
01/11	EML6155-001
01/13	EML6155-002
01/15	EML6155-003
01/18	Holiday (no lecture)
01/20	EML6155-004
01/22	EML6155-005
01/25	EML6155-006
01/27	EML6155-007
01/29	EML6155-008
02/01	EML6155-009
02/03	EML6155-010
02/05	EML6155-011
02/08	EML6155-012
02/10	EML6155-013
02/12	EML6155-014
02/15	EML6155-015
02/17	**Midterm Exam #1**
02/19	EML6155-016
02/22	EML6155-017
02/24	EML6155-018
02/26	EML6155-019
03/01	EML6155-020
03/03	EML6155-021
03/05	EML6155-022
03/08	EML6155-023
03/10	EML6155-024
03/12	EML6155-025
03/15	EML6155-026
03/17	EML6155-027
03/19	EML6155-028
03/22	EML6155-029
03/24	Recharge Day (no lecture)
03/26	**Midterm Exam #2**
03/29	EML6155-030
03/31	EML6155-031
04/02	EML6155-032
04/05	EML6155-033
04/07	EML6155-034
04/09	EML6155-035
04/12	EML6155-036
04/14	EML6155-037
04/16	EML6155-038
04/19	EML6155-039
04/21	EML6155-040