EML 6155 - Convection Heat Transfer – Spring 2022

Instructor:
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Class Hours & Place:
M-W-F, Period 5th (11:45AM to 12:35PM), CSE E122

Office Hours (Virtual):
M-W-F, Period 7th (1:55pm to 2:45pm)
Note: These are the proposed office hours and can be changed upon request

Teaching Assistant & Supervised Teacher (Virtual):
Raju Bhatia, raju1@ufl.edu
Tue-Thu: 3:00pm to 4:30pm

Course Website: https://ufl.instructure.com/courses/446915

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 <u>neat.</u>
   Online submission: https://ufl.instructure.com/courses/446915

3. Exams:
   Mid-term Exam I **February 2nd, 8:20pm to 10:20pm**
   Location: TBA
   Mid-term Exam II **March 16th, 8:20pm to 10:20pm**
   Location: TBA
   Final Exam **April 28th, 10:00am to 12:00pm**
   Location: CSE E122
   No make-up exams will be given unless there is a valid reason consistent with the University policy.

4. Grading scale:

90-100	A
87-89.99	A-
83-86.99	B+
80-82.99	B
77 - 79.99	B-
73 - 76.99	C+
70 - 72.99	C
67 - 69.99	C-
63 - 66.99	D+

Holidays:

UF Recognized Holidays (<u>no class</u>):
Monday, January 17th (Martin Luther King Jr. Day)
M-W-F, March 7th-11th (Spring Break)

Class Policies:

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