MAE 550 **Foundations of Fluid Dynamics** Summer 2024

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| Section: 651  Office: EB III Room 3234 | Instructor: Prof. Tarek Echekki  Office Hours: Tuesdays 1-3 pm or by arrangement | |
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**Text (highly recommended)**: Pijush K. Kundu, Ira M. Cohen, and David R. Dowling, Fluid Mechanics, 5th or 6th Ed., Academic Press. This is a recommended textbook; it is not required. A link to the electronic version available through the NC State Libraries will be accessible through Moodle.

**Prerequisites**: MAE 201, MAE 252 or MAE 308 (Undergraduate Thermodynamics and Fluid Mechanics)

**Course Objectives:** The students will develop an understanding of the foundations of fluid dynamics. Through the study of MAE 550, the student will be able to:

* Develop tools for the characterization of fluid flow;
* Develop the basic equations for the transport of fluids;
* Be able to use these equations and derive simplified forms for a broad class of engineering problems;
* Be able to analyze some basic internal and external flows.

**Course Grade**: Homework 20%

Hour Tests (2) 50%

Final Exam 30%

The final grade will be based on the final average and determined as follows:

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| 1. (90 to < 93) | A (93 to < 97) | A+ (97 and above) |
| 1. (80 to < 83) | B (83 to < 87) | B+ (87 to < 90) |
| 1. (70 to < 73) | C (73 to < 77) | C+ (77 to < 80) |
| 1. (60 to < 63) | D (63 to < 67) | D+ (67 to < 70) |
| F < 60 |  |  |

**Course Syllabus:**

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| **Topic** | **Kundu & Cohen**  **4th Edition** | **Kundu, Cohen and Dowling 5th Edition** |
| Introductory concepts | Chap. 1 | Chap. 1 |
| Vectors, tensors and integral theorems | Chap. 2 | Chap. 2 |
| Kinematics of local fluid motion: Lagrangian and Eulerian descriptions, substantial or material derivatives, decomposition of motion, vorticity, rate of strain, streamline coordinates | Chap. 3 | Chap. 3 |
| The Navier-Stokes equations: the stress tensor, differential forms for mass continuity, momentum, energy, angular momentum, second law, vorticity … | Chap. 4, 5 | Chap. 4, 5 |
| Variants of the Navier-Stokes equations and approximations (Inviscid: Euler and Bernoulli, Stokes flow, Boussinesq…) | Chap. 4 | Chap. 4 |
| Some solutions of the Navier-Stokes equations | Chap. 9 | Chap. 8 |
| Boundary layers | Chap. 10 | Chap. 9 |

**POLICIES AND PROCEDURES**

1. There will be two tests and a final examination and frequent homework assignments. All exams will be proctored and closed book.
2. Arrangements for missed tests and potential conflicts with exam windows are made on an individual basis provided there is an acceptable, certifiable excuse.
3. Students are highly encouraged to do homework problems as assigned. The following procedure is recommended when attempting homework problems as well as for all solutions on tests and exams.

* State the problem and draw the appropriate system or control volume if possible.
* State clearly the assumptions you make and state the basic equations you use.
* Show all the steps needed to find your final answer.
* If you present a graph as part of a solution, label the axes, the curve; include the units and choose a scale that can be easily interpolated. Regardless, please do not plot graphs by hand (I do get that occasionally!).
* Place your final answer or conclusion in a box so that it stands out.