AOE 5104  ADVANCED AERO/HYDRODYNAMICS

Instructor:  W. J. Devenport, 660 McBryde Hall, Tel: 231-4456, Email: devenport@vt.edu
Office Hours:  Mondays and Wednesdays 1-2pm
Course website: http://www.aoe.vt.edu/aoe5104

Aris R, Vectors, Tensors and the Basic Equations of Fluid Mechanics, Dover, 1990 ($15 from Amazon)

Grading:  Homework (lowest homework grade ignored) 33%, Tests (2) 33%, Final 33%

COURSE PLAN
A working knowledge of Matlab programming will be assumed.

PART I. General Fluid Dynamics.
1. Introduction.
   Appreciation of fluid dynamics, some basic concepts.
2. Review of essential vector algebra and calculus.
   Definitions, coordinate systems, basic vector algebra.
   Differential changes in unit vectors, calculus of vector fields w.r.t. time.
   Calculus of vector fields w.r.t. space; line, surface and volume integrals, div, grad, curl and associated
   theorems, irrotational and solenoidal fields.
3. Derivation of the equations of motion.
   Lagrangian and Eulerian views, the substantial derivative and the Reynolds transport theorem
   Derivations of the equations of mass, momentum and energy conservation. Constitutive relations, the Navier
   Stokes equations and the viscous-flow energy equation. Boundary conditions.
   Equations for a static fluid.
4. Streamlines and vorticity.
   Streamlines and streamfunction.
   Vorticity, circulation and vortex theorems.

TEST 1

Part II. Ideal Flow
5. Assumptions and their consequences.
   Neglecting viscosity, neglecting compressibility.
   Derivation of Bernoulli’s equation for (a) steady flow (b) irrotational flow.
   The assumption of irrotationality.
6. General irrotational ideal flow.
   Problem of a body moving in an ideal fluid.
7. 2D ideal flow.
   Review of complex number theory. General solution.
   Velocity, streamfunction, velocity potential and their complex number representations.
8. Applications
   Conformal mapping.
   Panel Methods.
   Thin-airfoil theory.
9. 3D potential flow.
   Axisymmetric elementary flows and their combination, flow past as sphere, line vortices, the Biot Savart law
10. Applications.
    Non-lifting bodies. Panel Methods.
    Wings. Panel Methods
    Prandtl’s lifting-line theory.

TEST 2
COURSE OBJECTIVES

A detailed list of the course objectives may be found online at http://www.aoe.vt.edu/aoe5104/objectives.html

COMPUTER USE IN CLASS

Please do not use laptops in class. Tablet computers folded flat, and used exclusively for note taking are acceptable. Please check with me before using your computer if you are not sure.

HONOR CODE

All students must adhere to the Honor Code Policies of Virginia Tech. The Honor Code will be strictly enforced in this course. All assignments shall be considered graded work, unless otherwise noted. All aspects of your coursework are covered by the honor system. Any suspected violations of the Honor Code will be promptly reported to the honor system. Honesty in your academic work will develop into professional integrity. The faculty and students of Virginia Tech will not tolerate any form of academic dishonesty.

ACCOMMODATIONS

Students are encouraged to address any special needs or special accommodations with me during the first two weeks of the semester, or as soon as you become aware of your needs. Those seeking accommodations based on disabilities should obtain a Faculty Letter from the Services for Students with Disabilities office (540–231–0858) located at 310 Lavery Hall (above Turner Place Dining Center).