Course Description: This course offers topics of advanced study in the numerical solution to compressible fluid flow problems.

Prerequisites:
- AOE 4984/5984: Intro CFD (or equivalent)
- AOE 5184: Advanced Aero and Hydrodynamics (or equivalent)
- MATH 3144: Linear Algebra (or equivalent)
- or permission of instructor


Instructor: Dr. Chris Roy, Associate Professor, Aerospace and Ocean Engineering Dept.

Prerequisites by Topic: Governing equations for fluid dynamics, partial differential equations, introductory CFD, linear algebra

Topics:
1. Review of the basics of CFD
2. Euler equations: focus on 2D/axisymmetric form
3. Software engineering for CFD
4. Discretization approaches: focus on the finite volume method
5. Code verification review
6. Characteristic decomposition of the Euler equations: flux Jacobians, Eigenvalue analysis, similarity transformations, compatibility relations
7. Upwind schemes: approaches, second-order methods (κ-schemes), flux limiters, low dissipation schemes
8. Temporal integration methods: explicit, implicit, time accuracy
9. Mesh transformations
10. Solution verification review
11. Navier-Stokes equations in 2D/axisymmetric form
12. CFD applications: Fluent
13. Advanced topics – time permitting (e.g., preconditioning, multigrid methods, parallel computing via MPI, unstructured grids, RANS turbulence modeling, non-deterministic simulations)

**Grading:**

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**Project:** While a number of smaller programming assignments will be given as part of the homework, an individual project will also be assigned during the semester. The choice of programming language is left up to you; however, the instructor will be able to help with programming language syntax mainly for Fortran. The other recommended programming language is C. While C++ is probably fine too (although I recommend you stay away from object oriented paradigms for this project), I do not recommend you using Matlab since it will likely run much slower (factor of 10?) than both Fortran and C/C++. A very good Fortran 90/95 textbook is: Stephen J. Chapman, *Fortran 90/95 for Scientists and Engineers*, 2nd Ed., McGraw-Hill, Boston, 2004.

**Office Hours:** I prefer that you come in during office hours; however, if my office door is open then I am usually free to answer questions.

*Dr. Chris Roy*, Rm. 330 Randolph Hall, 231-0080, [cjroy@vt.edu](mailto:cjroy@vt.edu)
Office Hours: Mondays 1:30-2:30 pm and Tuesdays 9:30-10:30 am

**Test/Exam Policy:** All tests and exams will be open notes and open book.

**Class Web Page:** via Blackboard ([http://learn.vt.edu/](http://learn.vt.edu/))

**Attendance Policy:** You are expected to attend all class lectures.

**Special Needs:** Students who need accommodations are asked to arrange a meeting with me during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by Email.