Introduction to Computational Fluid Dynamics

AME 535b, 3 Units, Spring 2017

Lecture 11:00-12:20, MW, OHE 100B

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Course Objectives:

The goal of the course is to provide a description of advanced techniques which proved successful for specific flows encountered in aerospace and mechanical engineering and are presently used in industrial and research CFD codes. The students should become proficient in designing and modifying computer programs and interpreting physical information generated by these programs. The required background is knowledge of fundamental techniques used to discretize and solve partial differential equations describing diffusion and advection processes in one and two dimensions. Such a background is provided, for instance, by the AME 535a course.

Recommended Preparation:

AME 526 (or an equivalent course in partial differential equations) and AME 535a or an equivalent course in elementary CFD. The numerical programs provided as a part of coarse materials are written in FORTRAN. Therefore, working knowledge of FORTRAN is useful to complete many homework assignments. Otherwise, students without knowledge of FORTRAN will need to implement the algorithms from scratch in a computer language of their choice. However, for most programs MATLAB versions will be available as well.

Lecture Schedule:

Week	Dates	Topics
1		Inviscid compressible flow; 1-D Euler equations; shocks; artificial viscosity.
2		Flux Corrected Transport method; Total Variation Diminishing schemes.
3		Incompressible flows; artificial compressibility method.
4		Staggered grids; Marker and Cell method.
5		Projection methods; SIMPLE-type formulations.
6		High order spectral methods.
7		High order compact methods.
8		Commercial code.
9		Commercial code.
10		Introduction to the physics of turbulence; Reynolds equations; Kolmogorov theory.
11		Numerical simulations of turbulent flows; closure problem; turbulent/eddy viscosity concept.
12		Algebraic and mixing length models. Turbulent kinetic energy equation.
13		One and two-equation turbulence models (k-epsilon and k-omega).
14		Large eddy simulation methodology.
15		Subgrid scale models for LES. Final project review.
	May 3	Final Project due.

Course Materials:

Handouts, notes, and programs will be distributed in class.
The following required text can be found at the bookstore or in online booksellers:

- C.A.J. Fletcher, Computational Techniques for Fluid Dynamics, Vol. II, Springer-Verlag.

Additional textbooks in CFD (not required):

- J.H. Ferziger and M. Peric, Computational Methods for Fluid Dynamics, Springer-Verlag.
- R. Peyret and T.D. Taylor, Computational Methods for Fluid Flow, Springer-Verlag.
- J.C. Tannehill, D.A. Anderson, R.H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis.

Grading:

- 30 % Homework
- 60 % Final Project
- 10 % Participation

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* http://equity.usc.edu or to the *Department of Public Safety* http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage http://sarc.usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information http://emergency.usc.edu* will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.

Page last updated: October 26, 2016.
The contents of this web page are subject to change. Weekly information will be updated without notice. Change in policies, important dates, and project content will be announced in class.