MECH 539: Computational Aerodynamics (Winter 2013)

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Office Hours: Tuesdays and Thursdays 2:30-4pm.

Number of Credits: 3

Expected Outcome: At the end of the course, the student should be able to explain and apply the algorithms to compute and solve one-dimensional and basic two-dimensional aerodynamic flows.

Objective: For the analysis of flows past real aircraft configurations or of the internal flows in engineering systems, the theoretical methods studied in previous aerodynamic courses (such as Subsonic Aerodynamics, High Speed Aerodynamics and Unsteady Aerodynamics) have to be replaced by efficient computational methods capable of solving the flows in complex configurations. The basic computational methods are studied in this course.

At the end of this course, the students should know the basic numerical methods of solutions for subsonic and supersonic flows (such as panel, finite difference and finite volume methods) and should be able to apply them to solve typical flow problems.

Evaluation: 75% Project Assignments
25% Final Project

Project Assignments: There will be 5 project assignments. Each assignment is worth 15% of the total grade. Assignments will be posted on WebCT every two weeks. Assignments are due at the beginning of class on the assigned due date. Late assignments WILL BE ACCEPTED with a 25% penalty except under truly exceptional circumstances (Hospital Stay).

Final Project and Oral Presentation: The final project will cover material from the entire course content described in this syllabus and count for 25% of the grade.

The course evaluation scheme set out in this syllabus might require change under circumstances that are beyond the control of the instructor. In these cases, every effort will be made to obtain the consensus from the entire class.

Academic Integrity
McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/integrity for more information).

Students with Special Needs
If you have a disability and feel you need accommodations in this course, please follow the McGill guidelines for this. I will happily accommodate any student who has consulted with the appropriate Disability Services Department at McGill.

Course Content:

1. Introduction to Scientific Computing
    a. Approximation in Scientific Computing: absolute and relative errors, data and computational errors, truncation and rounding errors.
    b. Computer Arithmetic: floating point numbers and arithmetic, rounding, machine precision.
2. Basic equations of fluid motion in conservation form and using the primitive variables.
3. Panel method for aerofoil analysis using uniform source panels on the airfoil contour and linearly- variable doublet panels on the camberline. Three-dimensional panel methods for wings of finite span.
4. Transonic Small Disturbance Theory.
5. Various classical methods for the temporal and spatial discretizations applied to simple model equations. Explicit and implicit methods.
6. Consistency. Discrete perturbation and Von Neumann stability analyses. Numerical versus physical characteristics. Convergence. Accuracy analysis. Dissipation and dispersion.
7. Finite-difference, finite-volume, and finite-element formulations for solving the Euler equations in subsonic, transonic and supersonic regimes.
8. Boundary conditions for PDEs.
9. Explicit time-marching methods. Two-dimensional and quasi 1-D formulations. Applications to confined compressible flows in nozzles and past airfoils.