Computational Fluid Dynamics I - Course Syllabus

Course Number: ME305A

Course Title: Computational Fluid Dynamics I

Academic Semester: Spring  Academic Year: 2015/2016
Semester Start Date: Jan 24, 2016  Semester End Date: May 19, 2016

Class Schedule: MW 10:30-12:00

Classroom Number: TBD

Instructor(s) Name(s): Hong Im
Email: hong.im@kaust.edu.sa

Office Location: Bldg. 5, Room 4221
Office Hours: MW 13:00-14:00
Teaching Assistant name: N/A
Email:

COURSE DESCRIPTION FROM PROGRAM GUIDE

Introduction to floating point arithmetic. Introduction to numerical methods for Euler and Navier-Stokes equations with emphasis on error analysis, consistency, accuracy and stability. Modified equation analysis (dispersion vs. dissipation) and Von Neumann stability analysis. Finite difference methods, finite volume and spectral element methods. Explicit vs. implicit time stepping methods. Solution of systems of linear algebraic systems. Higher-order vs. higher resolution methods. Computation of turbulent flows. Compressible flows with high-resolution shock-capturing methods (e.g. PPM, MUSCL, WENO). Theory of Riemann problems and weak solutions for hyperbolic equations.

COMPREHENSIVE COURSE DESCRIPTION

The overarching goal of the course is to learn how to solve the Navier-Stokes and Euler equations for engineering problems using computational algorithms and programming. Various numerical solution techniques will be introduced and applied to several course projects.
GOALS AND OBJECTIVES

Specific objectives may be summarized as:

• To understand mathematical characteristics of partial differential equations.
• To understand basic properties of computational methods – accuracy, stability, consistency
• To learn computational solution techniques for time integration of ordinary differential equations
• To learn computational solution techniques for various types of partial differential equations
• To learn how to computationally solve Euler and Navier-Stokes equations
• To acquire basic programming and graphic skills to conduct the flow field calculations and data analysis.

REQUIRED KNOWLEDGE

ME200A/B Fluid Dynamics, AMCS201/202 Applied Mathematics

REFERENCE TEXTS

Lecture Notes (Powerpoint presentation)

Additional Handouts

Recommended Books:

METHOD OF EVALUATION

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<tr>
<th>Graded content</th>
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<td>Homework (30%), Midterm/Final Exams (30%), Projects (40%)</td>
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COURSE REQUIREMENTS

Assignments

Homework: analytical questions reviewing basic lecture material
Projects: programming exercise to solve problems and analyze the results
Exams: in-class closed-book exams to review basic concepts

Course Policies

Homework/projects are expected to be submitted by 5pm on the due date. Late submissions are only allowed by advance notice at least by 24 hours. Acceptance of extension will be at instructor’s discretion.

Additional Information

Background needed:

Undergraduate numerical analysis. Graduate-level fluid mechanics. Basic computer programming language (Matlab, Fortran, C, C++) and graphics skills.

NOTE

The instructor reserves the right to make changes to this syllabus as necessary.