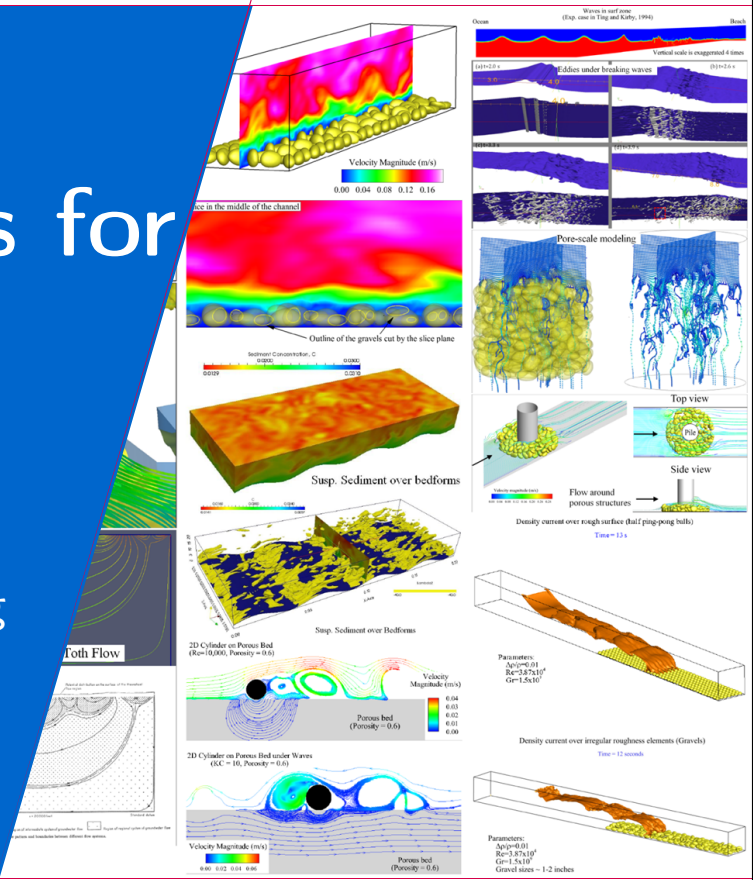
PENNSTATE

1855

CE597D Special Topics, Fall, 2014

Computational Methods for Environmental Flows



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Outline

Administrative Issues

- Instructor: Dr. Xiaofeng Liu
  - Office: 223B Sackett
  - Phone: 3-2940
  - Email: xliu@psu.edu
- Class meeting: TR 4:15-5:30 pm (215 Hammond Bldg)
- Office hours: M 10:00-12:00 (223B Sackett) or by appointment
- Books and references
  - (**Required**) H. Versteeg and W. Malalasekera (2007). An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Prentice Hall.
  - D.C. Wilcox, Turbulence Modeling for CFD (Third Edition)
  - J. H. Ferziger, M. Peric, Computational Methods for Fluid Dynamics, Springer, 3rd Ed., 2001.
  - Paul D. Bates, Stuart N. Lane, Robert I. (2005) Computational Fluid Dynamics: Applications in Environmental Hydraulics
  - Handouts

Suggested Prerequisites

- Courses:
  - Fluid Mechanics
  - Numerical Methods
- Suggested courses (not required):
  - Some exposure to high performance computing
- Major prerequisites by topic:
  - Understanding of basic fluid mechanics and hydraulics
  - Student from other areas: fundamental laws and governing equations in their fields
  - Understanding of basic numerical methods
- Computer skills (will train)
  - Linux: Command line operations
  - Programming: C++ and object oriented programming

Topics covered (tentative)

- Introduction: aims and scope, CFD, student feedback
- Introduction of OpenFOAM®
  - Basic level: How to use
- Review of fluid mechanics and governing equations
- Numerical solution of partial differential equations
  - Classification of PDEs
  - Numerical solution of diffusion equations
  - Numerical solution of advection-diffusion equations
  - Numerical solution of unsteady problems
  - Special treatment of unstructured meshes
- Introduction of OpenFOAM®
  - Intermediate and advanced levels: Programming and customization
- Turbulence modeling
- Parallel computing
- Solute and particle transport modeling (optional)
- Interface modeling (optional)
- Postprocessing: Data analysis and scientific visualization

Course objectives

- Understanding of how to use computational tools to solve mathematical problems
- Know how to write computer code given a set to mathematical model
- Understanding of how to interpret the computational results
- Technical writing and presentation

Evaluation method

- Homework assignments 40%
- Midterm exam 20%
- Term project 40%

All exams will be open book and notes

About homework

- There will be homework in the forms of "hand-written" and "computer problem".
  - Hand-written
    - could be typed.
    - Examples: derivation of equations and formulas, simple calculations
  - Computer problems
    - You need to use computer to solve the problem
    - Send in your computer code with your report.
    - Only include the most important part of the code in your report
    - Clearly document your code
    - submit the code as email attachment

About computing facility

- Our homework and projects will need computing facility
  - Personal computer can be used. But you need to install Linux and OpenFOAM on it.
  - Alternatives:
    - PSU hammer and lion-xxx: http://rcc.its.psu.edu/
    - NSF XSEDE: We have allocation award for this course on Stampede: https://www.xsede.org/web/guest/tacc-stampede
  - For PSU RCC computers, send me your PSU id and names. I will add you.
  - For Stampede, go to XSEDE webpage and create an account. Then let me know and I can add you.
  - Take care and be considerate to others when using the resources.

About term project

- You need to set up an appointment with the instructor to discuss this project
- Ideally, it will be something related to your research or thesis work
- Or it could be something the instructor suggests
- You need to think about the project from the beginning of the course and submit a project proposal (2 pages) no later than Oct. 7 (Tuesday).

Project proposal

- At least two pages; could be more if you have a clear picture of what you want to do
- Structure of the proposal
  - Background and introduction
    - Why you want to do this?
    - What has been done?
    - What has not been done?
    - What can be done and what you propose.
  - Technical details
    - The details of your plan: what computational tool you want to use, any modifications, simulation cases, analysis procedures, and anticipated results
  - Tentative time line
- You should inform the instructor frequently (weekly?) about your progress on the term project
  - Progress
  - Difficulties
  - Suggestions
  - etc.

Project report and presentation

- You are required to write a final report of the project
  - An expanded version of your proposal with results, analysis, and conclusions
  - The format of the report: You are encouraged to use LaTeXfor the writing.
    - Assistance on Latex is available from the instructor
    - You can use any LaTeXtemplate as you want as long as it is clear to make your point
    - Cite people's work and give credit by putting them to the reference
    - Absolutely zero-tolerance on copying and plagiarism

Project report and presentation

- You are also required to present your project
  - 20 min each (15 min talk + 5 min Q&A)
  - Well-organize and rehearse your slides: You are encouraged to use LaTeX(Beamer, for example)
  - Clearly convey your findings and points
  - Make it interesting and understandable to the general audience
  - Scientific visualization competition (judged by all students and instructor): pictures and animations. Winner will get a certificate.
  - Your presentation will be part of the term project evaluation
  - Presentation day: *Thursday, 12/11/2014*

Questions?