General Information [1]

1 Instructor

Professor:	Frederic Gibou	Email:	fgibou@ucsb.edu
Office:	Eng. II Bldg., Room 2335	Office Hours:	MW After class
Phone:	(805) 893-7152		

2 Grading

Your grade will be based on homework (50%) and a final project (50%). The goal of the project is to demonstrate the ability to understand the use of the level set method in a practical application. Examples include Free Surface Flows, Multiphase Flows, Image Segmentation, Graphics, Differential Geometry, etc. Students will present a research paper of their choice or taken from a list established by the instructor.

If you are a student with a disability and would like to discuss special academic accommodations, please contact me during my office hours.

3 Pre-requisites

Knowledge of a computer language suitable for numerical computing: C, C++, FORTRAN, Python, Matlab, etc. Previous knowledge in Numerical Analysis is strongly recommended. I will try to make the class self-contained but you might want to consult the references below as needed.

4 References

- Level Set Methods and Dynamic Implicit Surfaces, Osher and Fedkiw.
- Level Set Methods and Fast Marching Methods, J.A. Sethian.
- Finite Difference Schemes and Partial Differential Equations, J. Strikwerda.
- Numerical Methods for Conservation Laws, R. Leveque.
- Riemann Solvers and Numerical Methods for Fluid Dynamics, E. Toro.
- Numerical Analysis, by R. Burden and J. Faires.
- Elementary Applied Partial Differential Equations, R. Haberman.
- Relevant handouts will be given in class.

[1] All the information about this class will be posted at https://sites.engineering.ucsb.edu/~fgibou/LevelSet216.html

5 Syllabus

- Introduction
  - Goals for the Class
  - Explicit Versus Implicit Representations
  - The Level Set Representation
- Main Equations $\hookrightarrow$ Hamilton-Jacobi Equations
  - The Level Set Equation
  - The Reinitialization Equation
  - Extrapolation in the normal direction
- Numerical Approximations of Hamilton-Jacobi Equations
  - Link between Hamilton-Jacobi and Conservation Laws
  - Numerical schemes for Conservation Laws
  - Numerical schemes for Hamilton-Jacobi
    1. ENO and WENO schemes
    2. Godunov Method
    3. Lax-Friedrichs Schemes
- Applications (Free Surface Flows, Stefan Problem, Ghost Fluid Method)
  - A User Friendly Guide to Level Set Methods
  - Coupling Level Set with Physics (Free Surface Flows, Stefan Problems, Image segmentation)
  - Imposing Boundary Conditions

6 Expanded Resources for Students

The Division of Student Affairs provides essential support services and resources to help UCSB students handle the challenges of university life:

1. Help during exams
   Students with disabilities may request academic accommodations for exams online through the UCSB Disabled Students Program at http://dsp.sa.ucsb.edu/. Please make your requests for exam accommodations through the online system as early in the quarter as possible to ensure arrangement.
2. Managing stress
   Personal concerns such as stress, anxiety, relationships, depression, cultural differences, can interfere with the ability of students to succeed and thrive. For helpful resources, please contact UCSB Counseling & Psychological Services (CAPS) at 805-893-4411 or visit http://counseling.sa.ucsb.edu/

3. Responsible scholarship

   Honesty and integrity in all academic work is essential for a valuable educational experience. The Office of Judicial Affairs has policies, tips, and resources for proper citation use, recognizing actions considered to be cheating or other forms of academic theft, and students responsibilities, available on their website at: http://judicialaffairs.sa.ucsb.edu. Students are responsible for educating themselves on the policies and to abide by them.

   Furthermore, for general academic support, encourage students to visit Campus Learning Assistance Services (CLAS) early and often. CLAS offers instructional groups, drop-in tutoring, writing and ESL services, skills workshops and one-on-one consultations. CLAS is located on the third floor of the Student Resource Building, or visit http://clas.sa.ucsb.edu.

4. Mental Health Statement

   Students may feel overwhelmed or depressed with coursework, stress and/or other personal challenges. If you find yourself, or another student, in need of support, please do not hesitate to reach out to Counseling and Psychological Services (CAPS), 24/7 at (805) 893-4411. http://caps.sa.ucsb.edu/

5. Gender and Sex Discrimination Policy and Student Support

   Under Title IX, university students are protected from harassment and discrimination based on gender and sex. If a student feels uncomfortable or in need of support at any time related to their gender, sex, and/or sexual orientation, please contact your TA and/or course instructor immediately. If a student would like to disclose information related to pronouns, name changes, or identities, we encourage you to do so. UCSB's Resource Center for Sexual and Gender Diversity on the 3rd floor of the Student Resource Building is also available to advocate and be of and support to students.