Instructor: Spyros A. Kinnas, **Office:** ECJ 8.610, *kinnas@mail.utexas.edu*

Meeting times and place: Tuesday and Thursday, 12:30 – 2:00pm – **Face-to-face in CPE 2.212**

Academic/learning goals for the course: (a) Understand the *fundamentals* of general (with *minimal assumptions*) inviscid and viscous flow of incompressible fluids (with emphasis on wave theory) and their *applications* to coastal engineering and offshore energy technology; (b) be introduced to advanced predictive techniques (e.g. CFD, Computational Fluid Dynamics) to model realistic flows around realistic bodies; and (c) use these techniques (CFD) to predict the viscous flow around an object, and to design an object for optimal performance.

How the academic/learning goals will be assessed: goal (a) (defined above) will be assessed through the results of homework assignments and the two tests, and goals (b) and (c) (defined above) will be assessed through the results of the homework assignments and the term project.

Prerequisites: Elementary Fluid Mechanics (CE319F) or equivalent in other departments or schools.

Kinnas office hours (Hybrid): Wednesdays 3:00 - 4:30pm - or by appointment

TA: Mr. Thomas S. Wu, OE Graduate Student, th0mas@utexas.edu

TA office hours (ONLINE): TBA

Q+A: In addition to asking your questions in class or during office hours, you may also submit your questions via email to *kinnas@mail.utexas.edu*. Your questions (anonymous) with the answers will be sent via email to all the students in class. The questions will be answered on a first come/first serve basis, and according to the availability of the instructor. Questions on the HW will NOT be answered if submitted after the end of the last office hours prior to the deadline.

Required Text: Excerpts from Shore Protection Manual (SPM), U.S. Army Corps of Engineers, USACE (1984). Available online:

- Volume 1: *https://www.archive.org/details/shoreprotectionm01unit*
- Volume 2: *https://www.archive.org/details/shoreprotectionm02unit*

Class-notes: Typed class-notes with figures, example problems, advanced topics, links, and *interactive simulations*. Other class-notes will be distributed occasionally through the course web site.

Course web site: *https://www.caee.utexas.edu/prof/kinnas/ce358/ce358.html*
It includes additional handouts, helpful animations, example problems, homework assignments, solutions, sample tests. Note: The solution to the example problems will be provided ONLY in class.

The University of Texas at Austin provides, upon request, appropriate academic accommodations for qualified students with disabilities. For more information, contact the Division of Diversity and Community Engagement, Disability & Access, 512-471-6259 (email: access@austin.utexas.edu) or http://diversity.utexas.edu/disability/

On reserve (NOT required, only for additional reading, in Dr. Kinnas' office)

- *Water Wave Mechanics for Engineers and Scientists*, by Dean, R.G. and Dalrymple, R.A.,World Scientific (1984, 1991).
- *Basic Wave Mechanics for Coastal and Ocean Engineering*, by Sorensen, R.M., John Wiley & Sons (1993)
- *Hydrodynamics of Offshore Structures*, by S.K. Chakrabarti, WIT Press (2001, latest edition).
- *Wave Forces on Offshore Structures, by T. Sarpkaya, Cambridge University Press (2010)*
- *Ocean Engineering Mechanics, by M.E. McCormick, Cambridge University Press (2010)*

Grading policy: Homework: 20%; Test I: 27%; Test II: 28%, Term Project – Part I: 6%; Term Project – Part II: 19%. The plus/minus grading system will be followed (with APPROXIMATE range of numerical grade out of 100):

A: 4.0 (>95); A-: 3.67 (90-94.9)
B+: 3.33 (87-88.9); B: 3.0 (83-86.9); B-: 2.67 (80-82.9)
C+: 2.33 (77-79.9); C: 2.0 (73-76.9); C-:1.67 (70-72.9)
D+:1.33 (65-69.9); D: 1.0 (60-64.9); D- : 0.67 (55-59.9)
F: 0 (<55)

Tests/Term Project:

- Test I: **Tuesday, October 10, 2023** **(A-L: 5-7pm; M-Z: 7-9pm – IN PERSON - in a different room from the classroom – Regular class to be canceled)**
- Test II: **Tuesday, November 14, 2023** **(A-L: 5-7pm; M-Z: 7-9pm – IN PERSON - in a different room from the classroom – Regular class to be canceled)**
- Final Exam: NO Final Exam (Pending approval by the Dean's office)
- Term project (in lieu of Final) – **Part II report due Friday, December 8**

Failure to attend a test will lead to a mark of zero. The only exception will be for documented medical emergencies.

Homework: Original assignments must be submitted on Canvas (**as pdf files**) by each student. Solutions will be posted on the web site following the due date of each assignment. The homework assignment will be graded for *solution procedure, numerical results, clarity and appearance of the report*. Students must provide all intermediate steps that lead to the final answer of each question. Only *computer-generated graphs* will be accepted. The HW assignments will be posted on the course web site every week and will be due one week after the date of their posting. Students must submit their solutions, via Canvas, **by 11:59pm** on the assigned due date. **Late assignments will get 50% of the grade if submitted by 11:59pm the day after the deadline, and 0 points if submitted AFTER the solutions have been posted on Canvas. Submitting the wrong assignment or an unreadable file on Canvas will receive 0 points. Please always check to make sure you have submitted the correct homework. You are allowed to have 2 late HWs (which will get full credit), as long as they are submitted BEFORE the solutions are posted on Canvas.**

Term Project: Part I of the term project will be assigned individually to each student. Part II of the project will be assigned to teams of three-four students each, and will address the *design* of an object (underwater or tidal turbine for energy extraction from tides or ocean currents) in contact with a fluid, using a commercial software package that will be available at LRC, and/or other software that have been developed by the Ocean Engineering Group at UT Austin. The designs will be then *printed* at UT's 3D printers, and *tested* at UT/CAEE's flume in the Fluids and Hydraulics Lab. A comprehensive (typed) report on the project should be submitted by the end of the semester.

Scholastic Dishonesty Policy: ***Sharing of Course Materials is Prohibited: No materials*** used in this class, including, but not limited to, lecture hand-outs, videos, assessments (quizzes, exams, papers, projects, homework assignments), in-class materials, review sheets, and additional problem sets, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. I am well aware of the sites used for sharing materials, and any materials found online that are associated with you, or any suspected unauthorized sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. **These reports can result in sanctions, including failure in the course**.
For additional information on **Academic Dishonesty, UT Honor Code (or statement of ethics)**, and an explanation on what constitutes **plagiarism**, see the Dean of students' website and University General Information Catalog at: http://deanofstudents.utexas.edu/conduct/ and https://catalog.utexas.edu/general-information/appendices/appendix-c/student-conduct-and-academic-integrity/

COVID Caveats: Important Safety Information: COVID-19 Information and resources: https://protect.utexas.edu/

Attendance: Highly recommended. Does not count in the final grade. Classes will NOT be recorded, but Dr. Kinnas' hand-notes during class, will be made available through the class website. IMPORTANT NOTE: Being late in class causes significant disruption to the instructor and to the students, and should be avoided.

Dropping policy:

- **Undergraduate Students:** From the 1st through the 12th class day (4th class day in the summer sessions), an undergraduate student can drop a course via the web and receive a refund, if eligible. From the 13th (5th class day in the summer sessions) through the university's academic drop deadline, a student may Q drop a course with approval from the Dean, and departmental advisor.
- **Graduate Students:** From the 1st through the 4th class day, graduate students can drop a course via the web and receive a refund. During the 5th through 12th class day, graduate students must initiate drops in the department that offers the course and receive a refund. After the 12th class day, no refund is given. No class can be added after the 12th class day. From the 13th through the 20th class day, an automatic Q is assigned with approval from the Graduate Advisor and the Graduate Dean. From the 21st class day through the last class day, graduate students can drop a class with permission from the instructor, Graduate Advisor, and the Graduate Dean. **Students with 20-hr/week GRA/TA appointment or a fellowship may not drop below 9 hours**.

Emergency Preparedness Plan: Emergency Preparedness means being ready. It takes an effort by all of us to create and sustain an effective emergency preparedness system. You are your own best first responder. Please use https://preparedness.utexas.edu/welcome-emergency-preparedness as a resource to better understand emergency preparedness at the university, and how you can become part of and contribute to the preparedness community. To monitor emergency communications for specific instructions, go to https://utexas.edu/emergency. To report an issue (none emergency) call 512-471-4441. In case of emergency, call 911.
Course/Instructor Evaluation Plan: An evaluation of the course and instructor will be conducted at the end of the semester using the approved UT Course/Instructor evaluation forms.

All other university policies not explicitly included on this syllabus can be found on the General Information Catalog: http://catalog.utexas.edu/general-information/

Subject Matter of Lectures:

(Two lectures have been dedicated to the two tests, and are not included in the next list)

Lecture 1	o Some aspects of Ocean Engineering o Effect of waves and engineered structures on the coastline o Evolution of Offshore Structures o The Wave Basin at OTRC (Offshore Technology Research Center) o What is CFD?
Lectures 2 & 3	o Review of commonly used units. Review of trigonometric identities o Main characteristics of sinusoidal waves (Height, Length, Period, Celerity, Direction, and Phase) o Concept of float and its kinematics
Lectures 4 & 5	o Review of related math; Taylor expansion in one and two dimensions; higher order terms and physical meaning of 1st order approximation o Velocity flow-field and continuity equation o Concept of vorticity (definition and physical meaning) o Irrotational and rotational flow o Concept of velocity potential and the Laplace equation
Lectures 6, 7 & 8	o Acceleration of fluid particles and concept of material derivative o Euler equations for unsteady inviscid flows o Bernoulli equation for unsteady irrotational flows o Kinematic & dynamic boundary conditions and their physical meaning o Streamlines and pathlines
Lectures 9 & 10	o Linear wave theory o Waves in deep water and their velocity potential o Dispersion equation and expressions of wave length and wave speed in terms of wave period o Velocity flow-field, particle trajectories and accelerations o Pressure variation due to wave in deep water
Lectures 11, 12 & 13	o Waves in intermediate depth water and their velocity potential o Dispersion equation and expressions of wave length and wave speed in terms of wave period and water depth o Velocity flow-field, particle trajectories and accelerations o Pressure variation due to wave in intermediate depth water o Waves in shallow water, wave speed in terms of water depth o Velocity flow-field, particle trajectories, accelerations, and pressure variation due to wave in shallow water
Lectures 14 & 15	o The Navier-Stokes equations o Introduction to turbulence and its modeling o Introduction to the principles of CFD (Computational Fluid Dynamics) and the term project
Lectures 16 & 17	o Wave group, group velocity, and speed of wave front o The OTRC wave basin and US Navy's David Taylor Model Basin o Wave energy and wave power
Lectures 18 & 19	o Wave shoaling and tsunamis o The Sumatra tsunami and tsunami warning systems o Wave refraction and applications
Lectures 20, 21 & 22	o Inviscid and viscous flow around 2-D cylinder o Drag coefficient vs. Reynolds number, and effect of surface roughness o The concept of Added Mass (definition and physical meaning) and inertial coefficient o Wave forces on piles and the Morison equation o Drag and inertial coefficients used in practice for piles
Lecture 23	o Wave reflection and applications; standing waves
Lecture 24	o The Loop Current in the Gulf of Mexico, and VIV (Vortex Induced Vibrations) on risers or other components of offshore structures o Vibration of one-degree-of-freedom systems, and resonance
Lectures 25 & 26	o Random waves and wave spectrum o The significant wave height and period, and the 100-year storm wave o When are non-linear wave effects important, and introduction to non-linear wave theories

Relationship of the Course to Student Outcomes:

This course is designed to achieve the ABET Student Outcomes marked with a "X" in the first column.

	Student Outcomes
X	1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
X	2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
	3. An ability to communicate effectively with a range of audiences
	4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
X	5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
	6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
X	7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies