Unique Number: CE 397-32(15548, 15549) / ASE 382Q (13214)
Instructor: Spyros A. Kinnas Office**:** ECJ 8.610
Phone: 512-475-7969 **E mail:** *kinnas@mail.utexas.edu*
Course web site: *http://cavity.caee.utexas.edu/kinnas/COURSES/propturb.html*
Office hours: Monday 2:00 - 3:00 pm; Wednesday 2:00 – 3:00 pm

Course time: Tuesday and Thursday, 9:30 -11:00am, Classroom**:** ONLINE/ECJ 1.322

Objectives: Cover the *fundamentals* of lifting body theory and its applications to analysis and design of propellers and turbines, and provide *hands-on experience* with up-to date computational techniques.

Prerequisites: Graduate class in fluid mechanics, graduate standing, or consent of instructor

Computer: Familiarity with a programming language is expected.

Required Textbook: *Propulsion – The Principles of Naval Architecture*, by Kerwin and Hadler, published by the Society of Naval Architects and Marine Engineers, 2010.
Additional Web-notes and Papers: to be posted in class web-site regularly.

Class format: Lectures supplemented with outside reading, homework, term project, and one test.

Grading: Homework: 50%; Test: 30%; Term Project: 20%. Any problems, personal or otherwise, affecting grades should be brought to the instructor's attention.

Homework policy: Original assignments must be submitted by each student. Students must submit their solutions, via Canvas, b**y 11:59 pm** on the assigned due date. Late assignments will not be accepted. Some of the problems will require moderate amounts of computer programming. Only computer generated graphs will be accepted. The homework has to be *neat* and *orderly*.

Term Project policy: The lecturer and each student should meet to discuss an appropriate topic. A mixture of theoretical, numerical and design-oriented projects will be provided. Each of the students must submit an abstract of their planned work by **October 23, 2020**. Considerable effort must be devoted in the formulation of the problem, numerical implementation, programming, interpretation of the results, convergence of the proposed method, and comparisons with data from existing experiments (if available). Current propulsor analysis and design software will be provided, as needed. Each of the students must submit a *comprehensive report* on his or her project, due at the end of the semester.

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, Services for Students with Disabilities, 512-471-6259 (Videophone: 512-410-6644) or http://diversity.utexas.edu/disability/

Examinations: (tentative dates)

- One Test (Open Book, over 3 hours): towards the end of the semester.
- NO Final Exam (pending approval by the Dean's office)

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

Scholastic Dishonesty Policy: Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since such dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. For additional information on **Academic Dishonesty, UT Honor Code (or statement of ethics)**, and an explanation of what constitutes **plagiarism,** see the Deans of students website, and University General Information Catalog, at: http://catalog.utexas.edu/general-information/ and http://catalog.utexas.edu/general-information/appendices/appendix-c/student-discipline-and-conduct/

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.

Wearing a recommended protective face mask **at all times** when inside university buildings will be mandatory except when alone in a private office, eating in a campus dining facility or when students are in their own residence hall rooms. UT will encourage compliance by increasing awareness and fostering a spirit of cooperation. Students who refuse to follow directives to wear a mask will be referred to Student Conduct and Academic Integrity in the Office of the Dean of Students for disciplinary action. More information on how you can help keep our campus healthy this Fall can be found here: "Protect Texas Together."

Class Recordings: Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.

COVID Caveats: To help keep everyone at UT and in our community safe, it is critical that students report COVID-19 symptoms and testing, regardless of test results, to University Health Services, and faculty and staff report to the HealthPoint Occupational Health Program (OHP) as soon as possible. Please see this link to understand what needs to be reported. In addition, to help understand what to do if a fellow student in the class (or the instructor or TA) tests positive for COVID, see this University Health Services link.

Attendance: Highly recommended.

Dropping policy:

- **Undergraduate Students:**

  From the 1st through the 12th class day, an undergraduate student can drop a course via the web and receive a refund, if eligible. From the 13th 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.**

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. A student within the class will be asked to distribute and collect the evaluation forms, and to return them to the Department of Civil Engineering main office on the 4th-floor of ECJ Hall.

COURSE OUTLINE

1. Introduction
- Types of propulsors and turbines
- What matters in propulsor or turbine design?

2. Review of fundamentals
- Velocity, pressure and shear stresses of fluid flow
- Continuity and Navier-Stokes equations
- Vorticity equation and vortex stretching
- Inviscid/irrotational flow -Velocity potential -Bernoulli equation
- Kinematic boundary condition
- Lifting flows - Kutta condition

3. 2-D Hydrofoil Theory
- Flow equations and boundary conditions
- Conformal mapping and exact solutions
- Linearized hydrofoil theory
- The camber and the thickness problem
- Lighthill's rule
- Thickness/loading coupling

- Numerical methods (Vortex-Lattice and Panel methods)
- The "cavitation bucket" diagram
- Viscous/Inviscid flow coupling and comparison of results with those from RANS

4. 3-D Hydrofoil Theory

- Lifting surface theory
- Biot-Savart's Law
- Linearized lifting surface theory
- Lift and drag
- Lifting line theory and Optimum circulation distribution
- Numerical methods (Vortex-Lattice and Panel methods)

5. Actuator Disk /Lifting Line Theory/Lifting Surface Theory - Steady flow

- Actuator disk theory
- Lifting line theory
- The Lerbs-Wrench asymptotic formulas
- Optimum circulation distribution
- Applications to propellers and turbines
- Betz's condition and Lerb's criteria
- Numerical lifting line (vortex-horseshoe method)
- Numerical methods (vortex-lattice and panel methods/comparisons of results with those from RANS)

6. Propeller Theory - Unsteady flow

- 2-D Unsteady hydrofoil theory
- Wake harmonics and unsteady propeller theory
- Unsteady blade and shaft forces
- Propeller/hull interaction and effective wake prediction
- Numerical methods (vortex-lattice and panel methods/comparisons of results with those from RANS)

7. Sheet cavitation

- Free streamline theory - dynamic boundary condition
- Linearized cavity theory
- Design in the presence of cavitation
- Super-cavitating propellers
- Other types of cavitation
- Numerical methods (vortex-lattice and panel methods)

8. Other topics (if time allows)

- Propeller induced hull pressures
- Ducted propellers
- Water-jets
- Other types of propulsors