IMPORTANT:
Please refer to the USC Center for Excellence in Teaching for current best practices in syllabus and course design. This document is intended to be a customizable template that primarily includes the technical elements required for the Curriculum Office to forward your proposal to the UCOC.

CE 599 LINEAR AND NONLINEAR WAVES

Units: 2

Term—Day—Time:

IMPORTANT:
The general expectation for a standard format course offered in a standard 15-week term is that the number of 50-minute contact hours per week should equal the number of semester units indicated and that one semester unit entails 1 hour of class time and 2 hours of outside work (3 hours total) per week. Standard fall and spring sessions (001) require a final summative experience during the University scheduled final exam day and time.

Please refer to the *Contact Hours Reference* to see guidelines for courses that do not follow a standard format and/or a standard term.

Location: Physical address and/or course-related URLs, etc.

Instructor: Professor Thanasis Fokas

Office: my USC office
Office Hours: To be arranged after the days of teaching are set
Contact Info: Email: tf227@cam.ac.uk, phone number 323-899-8364

Teaching Assistant: NONE

IT Help: Group to contact for technological services, if applicable.
Hours of Service:
Contact Info: Email, phone number (office, cell), Skype, etc.

Course Description

The development of the so-called 'unified transform' (also known as the Fokas method) is considered as a major development in the analysis of linear and certain nonlinear PDEs. This course will discuss the impact of this method on certain important problems arising in engineering. In particular, new solution formulas will be presented for the oldest PDE, namely, the *wave equation*. Surprisingly, the solution of the Dirichlet, or Newman, or Robin boundary value problem on the finite interval of this classical equation, can be written explicitly in terms of the given data (in analogy with the solution of d'Alembert for the initial value problem). In addition, basic results for *water waves* will be summarised and new exciting developments will be presented. In this connection it is noted that this classical area has a huge literature dating back to Newton (1687), Euler (1761) and Bernoulli (1738). In terms of engineering applications, this topic impacts among others, harbour design, shipping, and tsunami prediction. In the form that the governing equations are derived from physical principles, the problem is prohibitively difficult, as it involves the solution of Laplace's equation in an unknown domain, which is itself determined by nonlinear boundary conditions that depend on this solution. The reformulation of this problem via the unified transform vastly reduces its complexity. This has led to new developments, which include computations of surface water waves, the discovery of new instabilities of waves in shallow water, the incorporation of large amplitude effects in the reconstruction of the surface wave profile from pressure data measured at the bottom, and the determination the bottom topography from surface wave data. More importantly, the unified transform allows the investigation of water waves in complicated domains. In this connection it is noted that it is erroneously widely accepted that, under certain asymptotic conditions, the water waves problem reduces to the Boussinesq, or the KdV, or the NLS equations. However, it will be shown in this course that this occurs only for very simple domains. The unified transform provides a way to treat the problem in the general case.

This course will be usefull for any student engineering interested in a hybrid analytical-numerical approach for solving important problems arising in engineering in general and in water waves in particular.

After the competion of this course it is expected that the students will be proficient in a new powerful technique for the solution of a variety of engineering problems.

DETAILED SYLLABUS

Week 1: The Unified Transform

Week 2:The Implementation of the Unified transform to the Wave Equation

Week 3: Reformulation of free-surface water waves

Week 4:Extension to three dimensions and to the case of a variable bottom

Week 5:Free surface water waves in complicated domains

Week 6:The derivation of several model equations, including the Boussinesq and the KdV equations.

Week 7:Analysis of the model equations.

Learning Objectives

(1) Ability to solve explicitely boundary value probems of the the wave equation in one dimension.The solution formulas provide the generalization of the classical d'Alembeerty solution of the initial value problem.
(2)Reformulation of the classical problem of the free surface water waves in two- space domensions.
(3)Extension of the approached introduced in (2) to tree -space dimensions and to complicated boundaries.
(4)Derivation of some classical equations,including the KdV formulation using the above formulation.
(5)Analysis of the asymptotic propertis of typical model equations

Identify what specific, measurable skills a student will obtain and be able to demonstrate by the end of the course. Learning objectives should be both taught and assessed in your course. They are aligned with your assignments, assessments and learning materials.

Prerequisite(s): course(s) that must be taken prior to this course.KNOWELDGE OF CALCULUS
Co-Requisite(s): course(s) that must be taken prior to or simultaneously.NA
Concurrent Enrollment: course(s) that must be taken simultaneously.NA
Recommended Preparation: course work or background that is advisable, not mandatory.ANY COURSE IN PDEs

Course Notes

Include grading type (e.g., Letter, Credit No/Credit, Numeric). Note any unique characteristics of the course of operating procedure. Is the course Web-Enhanced (i.e. Blackboard), Blended or Online? If copies of lecture slides and other class information will be posted on Blackboard, note that here. If multimedia or technology-enhanced learning strategies will be used, please describe them here. NOTES WILL BE PROVIDED

Technological Proficiency and Hardware/Software Required

If applicable, provide details of accessing course if not in a traditional classroom setting. **NONE**

Required Readings and Supplementary Materials

Required readings and supplementary materials. Where to access/purchase. NONE

Description and Assessment of Assignments

What kind of work is to be done and how should it be completed, i.e. how the learning outcome will be assessed. Include any assessment and grading rubrics to be used.

5 HOMEWORKS WILL BE ASSIGNED THAT WILL BE GRADED OUT OF 100

Grading Breakdown

Including the above detailed assignments, how will students be graded overall? Participation should not exceed 15% of the total grade. Where it does, the syllabus must provide an added explanation. No portion of the grade may be awarded for class attendance but non-attendance can be the basis for lowering the grade, when clearly stated on the syllabus. The sum of percentages must total 100%.

Assessment Tool (assignments)	Points	% of Grade
HOMEWORK 1	15	15
HOMEWORK 2	15	15
HOMEWORK 3	15	15
HOMEWORK 4	15	15
HOMEWORK 5	15	15
FINAL	25	25

Grading Scale

(Optional – the following is only an example of what one might look like if included)

Course final grades will be determined using the following scale

A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Assignment Submission Policy

Describe how and when assignments are to be submitted.

Grading Timeline

Announce a standard timeline for grading and feedback.

Additional Policies

Add any additional policies that students should be aware of: late assignments, missed classes, attendance expectations, use of technology in the classroom, etc.

Course Schedule: A Weekly Breakdown

Provide a detailed course calendar that includes a list of deliverables (homework assignments, examinations, etc.) broken down on a weekly basis. The format may vary, but the content must include:

- Subject matter (topic) or activity
- Required preparatory reading or tasks (e.g., viewing videos)
- Deliverables and when each deliverable is due. A blanket statement that there will be a deliverable due at a specified frequency (e.g., there will be homework due weekly) may obviate the need to state when certain deliverables are due

IMPORTANT:
In addition to in-class contact hours, all courses must also meet a minimum standard for out-of-class time, which accounts for time students spend on homework, readings, writing and other academic activities. Standard fall and spring sessions (001) require a final summative experience during the University scheduled final exam day and time.

	Topics/Daily Activities	**Readings/Preparation**	**Deliverables**
Week 1	Week 1. Preview of the course. The initial value problem of the wave equation and d'Alembert's solution. Solution of PDEs via separations of variables. Fourier transforms, Fourier series and the traditional approach to boundary value problems.		
Week 2	The unified transform for evolution PDEs on the half-line and the finite interval.		

Week 3	The forced wave equation on the half-line		
Week 4	The wave equation on the finite interval		
Week 5	Water waves in two dimensions in unbounded domains.		
Week 6	Water waves in three dimensions in unbounded domains		
Week 7	Derivation of the Boussinesq, KdV and KP equations.		
Week 8	**Water waves in bounded domains**		
Week 9			
Week 10			
Week 11			
Week 12			
Week 13			
Week 14			
Week 15			
FINAL			Refer to the final exam schedule in the USC *Schedule of Classes* at classes.usc.edu.

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See

additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) - (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention - (213) 821-4710
campussupport.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.