

University Of California, Berkeley
Department of Mechanical Engineering

ME 243—Advanced Methods in Free-Surface Flows (3 Units)

Graduate Course

Syllabus

CATALOG DESCRIPTION

Analytical and numerical methods in free-surface problems. Elements of inviscid external lifting and nonlifting flows. Analytical solutions in special coordinates systems. Integral-equation methods: formulations and implementations. Multiple-bodies interaction problems. Free-surface Green functions in two and three dimensions. Hybrid integral-equation methods. Finite-element formulations. Variational forms in time-harmonic flows. Finite-difference forms, stability, and accuracy. Boundary-fitted coordinates methods. Unsteady linearized wave-body interaction in time domain. Nonlinear breaking waves calculations. Particle dynamics. Extensive hands-on experience of microcomputers and/or workstations in developing solution.

COURSE PREREQUISITES

ME 260A or CEE 200A; ME 241B recommended or with Instructor's permission

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

No textbooks.

COURSE OBJECTIVES

To present a relatively broad spectrum of analytical and numerical methods commonly used in tackling wave-body interaction problems. Topics covered include classical techniques in special coordinate systems, modern computational techniques based on boundary-integral, finite-element, and boundary-fitted coordinates methods. Lectures focus on formulations and implementation techniques. Students are given opportunities to implement methods discussed in class on workstations or mainframe.

DESIRED COURSE OUTCOMES

Students will be conversant and have abilities to handle fluid-structure interactions problems with free-surface present.

TOPICS COVERED

Governing equations review, lifting surface flow, special solutions without free surface, integral equations, matched asymptotic methods, time-harmonic free-surface Green function, hybrid method, time-dependent flow, finite-element formulation, eigen-function matching, finite-difference forms.

CLASS/LABORATORY SCHEDULE

3 hours of lecture and 0-1 hour of discussion (variable)

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

Develop students at the graduate level abilities to conduct analytical and computational solution of wave-related problems.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

Term projects of topics selected by students to develop analytical or computational solutions. Presentations of elements of project completed. Oral final examination.

TOPICS COVERED/WEEKLY AGENDA

Week No. and primary Topics

- 1 Governing equations and basic theorems
- 2 Lifting flow, vortex formulation
- 3 Non-lifting flow, integral-equation formulation
- 4 Special coordinates for spheroidal shapes
- 5 Cascade flows and multi-body slender-ship.
- 6-7 Time-harmonic free-surface Green function
- 8 Hybrid methods. Eigen function matching
- 9-10 Finite-element formulation: Weighted residuals, Galerkin form.
- 11 Finite-difference forms, simple stability & accuracy analysis.
- 12 Boundary-fitted coordinates, numerical accuracy and stability
- 13 Fractional step and primitive variable formulation
- 14 Time-dependent breaking-wave computations
- 15 RRR week

PERSON(S) WHO PREPARED THIS DESCRIPTION

Professor Ronald Yeung, 10/5/2015

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): ADV MET FRE-SURF FL

TIE CODE: LECT

GRADING: Letter

SEMESTER OFFERED: Fall and Spring

COURSES THAT WILL RESTRICT CREDIT: None

INSTRUCTORS: R. W. Yeung

DURATION OF COURSE: 15 weeks

EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 11

IS COURSE REPEATABLE FOR CREDIT? No

CROSSLIST: None