Course description

The course introduces the basics of fluid-structure interaction (FSI) by a series of progressively complex problems. In the process, basics of fluid mechanics, wave hydrodynamics, floating system dynamics, and vibrations are also covered. Topics covered include linear wave theory, linear and non-linear oscillators, potential flow methods, wave force prediction methods, vortex-induced vibration and seakeeping.

Pre-requisites

MAT258, MEE 360, MEE 370 or permission from instructor.

Desirable: MAT453, MEE 462 or equivalent.

Instructor

Professor Krish P Thiagarajan (pronounced Tia-garage-jan)

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Learning Outcomes

On successful completion of the course, the student will be able to:

- Explain the nature of the physical interaction between engineering structures and their fluid environment;
- Explain and demonstrate the use of linear wave theory for offshore engineering calculations.
- Explain flow techniques applied in computational fluid dynamics and offshore engineering and naval architecture software;
- Determine the hydrodynamic response of floating and moored structures to waves, currents and wind.
Course assessment

Homeworks: 30%
Projects: 30%
Final exam: 40%

Syllabus

1. Steady and oscillating flows (no structure present)
   a. Wind and currents
   b. Waves
      i. Linear wave theory
2. Oscillating structures (with simplified fluid behavior)
   a. Linear oscillators
   b. Nonlinear oscillators
      i. Duffing equation
3. Fixed structures in steady flow
   a. Potential flow solution
   b. Fluid forces and D’Alembert’s paradox
   c. Boundary element approach
   d. Vortex shedding
4. Fixed structures in oscillatory flows
   a. Morison’s equation for wave forces
   b. Inertia and drag forces, coefficients
   c. Diffraction problem
   d. Use of BEM for solution
5. Oscillating structures in steady flow
   a. Vortex-induced vibration
      i. Due to wind
      ii. Due to currents
   b. Wake oscillator theory for FSI
6. 6DOF structures in real ocean
   a. Diffraction – radiation problem
   b. Frequency vs. time domain
   c. Linear seakeeping problem for ships
   d. Interaction with moorings
   e. Example structures: Offshore oil and gas platform, offshore wind turbine system, tidal turbines.
Online resources

Use will be made of online tools e.g. Blackboard for distance education students. Recorded lectures and lecture material are available on the web. Homeworks will be posted online, and solutions made available one week later. Projects will make use of software, which can be accessed via the Maine system. Alternatively, open source material or spreadsheets may be used. Instruction on accessing the software will be made available at the time of the project.

Reference material

Primary references will be:


In addition, the following references may be helpful.