جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Multi-Phase Flows - ME 302

Division	Physical Science and Engineering Division
Course Number	ME 302
Course Title	Multi-Phase Flows
Academic Semester	Fall
Academic Year	2018/2019
Semester Start Date	08/26/2018
Semester End Date	12/11/2018
Class Schedule (Days & Time)	02:30 PM - 04:00 PM | Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Sigurdur T Thoroddsen	Sigurdur.Thoroddsen@kaust.edu.sa	+966128082160		To Be Determined when course starts.

Teaching Assistant(s)

Name	Email
N/A	N/A

Course Information

Comprehensive Course Description	Selected topics in engineering two-phase flows with emphasis on practical problems in modern hydrosystems. Fundamental fluid mechanics, heat, mass and energy transport in multiphase flows. Surface tension, Young-Laplace equation. Foam, Plateau borders. Basic free-surface flows, capillary waves. Non-dimensional numbers. Wetting of solids. Contact lines and triple lines, Super-hydrophobicity. Marangoni-driven flows. Bubble and drop dynamics, Coalescence, Pinch-off self-similarity. Splashing and air entrapment. Liquid/vapor/gas (LVG) flows, nucleation, cavitating and boiling flows. Leidenfrost dynamics. Flow in porous media. Paticle-laden flows. Models of LVG flows; instabilities, dynamics and wave propagation. fluid/structure interactions. Discussion of two-phase flow problems in conventional, nuclear and geothermal power plants and other hydraulic systems. Separation vessels in petrochemical industry.
Course Description from Program Guide	Selected topics in engineering two-phase flows with emphasis on practical problems in modern hydrosystems. Fundamental fluid mechanics and heat, mass and energy transport in multiphase flows. Liquid/ vapor/gas (LVG) flows, nucleation, bubble dynamics, cavitating and boiling flows, models of LVG flows; instabilities, dynamics and wave propagation; fluid/structure interactions. Discussion of two-phase flow problems in conventional, nuclear and geothermal power plants, marine hydrofoils, and other hydraulic systems.
Goals and Objectives	Make the student familiar with the effects of bubbles, droplets or solid particles on the flow of a liquid in nature and industrial processes. By the end of the course the student should know how to classify the various different multiphase flows and know how to determine which mechanisms are at play for various different conditions which occur in natural processes and industry.
Required Knowledge	Basic knowledge of the Navier-Stokes equations. Basics of Thermodynamics. Vector Calculus.

Reference Texts	Lecture Notes will be loaded online before lectures. Students will be directed to classical scientific papers on the topics at hand. Useful texts on the various topics: o Foams: Structure and Dynamics, by Isabel Cantat et al., Oxford University Press (2013). o Physics of Wetting, by E. Y. Bormashenko. De Gruyter (2017). o Capillarity and Wetting Phenomena: Drops, Bubbles, Pearls, Waves, by de Gennes, Brochard-Wyart and Quere. Springer (2004). o Multiphase flow metering, by Gioia Falcone , Geoffrey F Hewitt. Elsevier Science (2009). o Fundamentals of Multiphase Flow, by Christopher Brennen (2005) o Computational Methods for Multiphase Flow: by Prosperetti and Tryggvason, Cambridge
Method of evaluation	**40.00**% - Midterm exam **40.00**% - Homework /Assignments **20.00**% - Group Project(s)
Nature of the assignments	Four bi-weekly homework will test knowledge of the topics. These should be individually solved. Group projects will include small lab experiments, data reduction and final presentation in class. Midterm exam will be given after 2/3 of lectures and will be closed book, closed notes. It will test basic conceptual knowledge.
Course Policies	Students should attend all lectures, unless getting approval from the instructor. Bi-weekly homework should be turned in on-time, but extra time can be given for legitimate reasons.
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 08/27/2018	Surface tension, Young-Laplace equation
1	Thu 08/30/2018	Foam, Plateau borders
2	Mon 09/03/2018	Basic free-surface flows, non-dimensional numbers
2	Thu 09/06/2018	Capillary waves
3	Mon 09/10/2018	Marangoni flows
3	Thu 09/13/2018	Wetting of solids. Contact lines and triple lines
4	Mon 09/17/2018	Superhydrophobicity and Superhydrophilicity
4	Thu 09/20/2018	Bubbles and Drops, natural oscillations
5	Mon 09/24/2018	Coalescence, Pinch-off self-similarity
5	Thu 09/27/2018	Splashing
6	Mon 10/01/2018	Basic thermodynamics review
6	Thu 10/04/2018	Leidenfrost dynamics
7	Mon 10/08/2018	Boiling
7	Thu 10/11/2018	Cavitation
8	Mon 10/15/2018	Flow of Liquid/vapor/gas (LVG)
8	Thu 10/18/2018	Flow of emulsions. Coarsening
9	Mon 10/22/2018	Bubbly Flow
9	Thu 10/25/2018	Metering of multiphase flow in pipes.
10	Mon 10/29/2018	Condensation
10	Thu 11/01/2018	Water-entry of projectiles
11	Mon 11/05/2018	Volcanoes and tephra formation
11	Thu 11/08/2018	Separation vessels in petrochemical industry
12	Mon 11/12/2018	Vapor explosions
12	Thu 11/15/2018	Taylor cones
13	Mon 11/19/2018	Electrospray and Electrospinning of nanofibers
13	Thu 11/22/2018	Micro-fluidics and emulsions
14	Mon 11/26/2018	Encapsulation
14	Thu 11/29/2018	Hele-Shaw flows. Taylor-Saffman instability.
15	Mon 12/03/2018	Flow in porous media
15	Thu 12/06/2018	Paticle-laden flows
16	Mon 12/10/2018	Final Presentation of Group Projects.

Note

The instructor reserves the right to make changes to this syllabus as necessary.