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

Course Syllabus: Fluid Mechanics - ME 200A

Division	Physical Science and Engineering Division
Course Number	ME 200A
Course Title	Fluid Mechanics
Academic Semester	Spring
Academic Year	2016/2017
Semester Start Date	01/22/2017
Semester End Date	05/18/2017
Class Schedule (Days & Time)	02:30 PM - 04:00 PM | Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Deanna Angele Monique Lacoste	deanna.lacoste@kaust.edu.sa	+966128084801	4336, 5, Al-Kindi (bldg. 5)	From 03/23/2017 to 05/18/2017: - Monday 2:30 PM - 4:00 PM - Thursday 1:30 PM - 3:00 PM
Gaetano Magnotti	GAETANO.MAGNOTTI@KAUST.EDU.SA	+966128082874	4335, 5, Al-Kindi (bldg. 5)	From 01/22/2017 to 03/23/2017: - Sunday 8:30 AM - 10:00 AM - Wednesday 8:30 AM - 10:00 AM

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	Fundamentals of fluid mechanics: - Basics: Continuum hypothesis - Surface tension - Material derivative - Kinematics - Lagrangian approach vs Eulerian approach - Governing equations: Reynolds transport theorem - Continuity - Euler equations - Constitutive equations - Dimensional analysis: Self similar solutions - Exact solutions of Navier-Stokes equations: Unidirectional flow - Stagnation point flow - Stokes first and second problems - Flow in converging and diverging channels - Stokes streamfuenction for axisymmetric flow - Bernouilli equation for unsteady flow - Potential flow: Kelvin's circulation theorem - Basic potential solutions - Doublet - Cavity collapse and cavitation - Complex potential - Flow in a sector - Airfoil theory - Sphere impact - Virtual mass - Blasius theorem - Conformal mapping - Schwarz Christoffel transformation - Bubble accelerations- Boundar integral methods - Vortex dynamics: Vorticity equation - Circulation vortex rings - Biot-Savart law - Hill's spherical vortex - Vorticity generation at a fress surface - Helicity - Surface waves: Gravity waves - Capillary waves - Group velocity - Waves in bubbles - Rotating flows: Taylor columns, Eckman layers - Experimental techniques: Hot wires, High-speed imaging - Particle Image Velocimetry - Laser Induced Fluorescence

Course Description from Program Guide	Fundamentals of fluid mechanics. Microscopic and macroscopic properties of liquids and gases; the continuum hypothesis; review of thermodynamics; general equations of motion; kinematics; stresses; constitutive relations; vorticity, circulation; Bernoullis equation; potential flow; thin-airfoil theory; surface gravity waves; buoyancy- driven flows; rotating flows; viscous creeping flow; viscous boundary layers; introduction to stability and turbulence; quasi one-dimensional compressible flow; shock waves; unsteady compressible flow; acoustics.
Goals and Objectives	The objective of the course is to provide the students with 1:) a foundation in fluid mechanics; 2) experience in the analytical formulations of basic fluid mechanics problems; 3) understanding of dimensional analysis and similitude, and knowledge of the fundamental non-dimensional groups in fluid-mechanics; 4) ability to distinguish between flow regimes based on non-dimensional groups; 5) ability to solve for simple internal and external flows; 5) experience in performing basic measurements in fluid mechanics.
Required Knowledge	Undergraduate fluid mechanics, AMCS 201 or equivalent.
Reference Texts	- P.K. Kundu and I.M. Cohen "Fluid Mechanics" Elsevier - D.J. Acheson "Elementary Fluid Dynamics" Oxford University Press - G.K. Batchelor "An Introduction to Fluid Dynamics" Cambridge University Press - I.G. Currie "Fundamental Mechanics of Fluids" McGraw and Hill
Method of evaluation	**30.00**% - Final exam **25.00**% - Scientific review article presentation **30.00**% - Midterm exam **15.00**% - Homework /Assignments
Nature of the assignments	Problems sets are given as homeworks. Midterm and Final exams are closed book, closed notes, closed cell phone/laptop. Scientific calculator is allowed. Reading assignments and oral presentations.
Course Policies	In case of unjustified absence, the student will have a penality of 10 % reduction of the final score per missing class. In case of justified absences, additional homework can be asked to the student, in order to ensure that he/she will have go through the corresponding material. Late homeworks will not be accepted.
Additional Information	

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Mon 01/23/2017 Thu 01/26/2017	- Basics: Continuum hypothesis; Surface tension - Vector calculus and index notation
2	Mon 01/30/2017 Thu 02/02/2017	- Material derivative; Kinematics; Lagrangian vs Eulerian - Governing Eq.: Reynolds Transport Theorem; Continuity; Euler equations; Constitutive equation
3	Mon 02/06/2017 Thu 02/09/2017	- Navier-Stokes equation; Boundary conditions - Dimensional analysis
4	Mon 02/13/2017 Thu 02/16/2017	- Self-similar solutions - Exact Solutions of N.-S.; Unidirectional flow
5	Mon 02/20/2017 Thu 02/23/2017	- Stagnation point flow - Stokes firts and second problems
6	Mon 02/27/2017 Thu 03/02/2017	- Flow in converging or diverging channel - Stokes streamfunction for axisymmetric flow
7	Mon 03/06/2017 Thu 03/09/2017	- Bernoulli equation for unsteady flow - Potential Flow; Kelvin's circulation theorem
8	Mon 03/13/2017 Thu 03/16/2017	- Basic potential solutions, doublet - Review
9	Mon 03/20/2017 Thu 03/23/2017	- Midterm exam - Potential flow: Complex potential - Flow in a sector
10	Mon 03/27/2017 Thu 03/30/2017	- Potential flow: Airfoil theory - Sphere impact - Virtual mass - Blasius theorem - Potential flow: Conformal mapping - Schwarz Christoffel transformation
11	Mon 04/03/2017 Thu 04/06/2017	- Potential flow: Bubble accelerations - Boundary integral methods - Vortex dynamics: Vorticity equation - Circulation
12	Mon 04/10/2017 Thu 04/13/2017	- Vortex dynamics: Vortex rings - Biot Savart law - Vortex dynamics: Hill's spherical vortex - Vorticity generation at a free surface - Helicity
13	Mon 04/17/2017 Thu 04/20/2017	- Surface waves: Gravity waves - Surface waves: Capillary waves - Group velocity - Waves on bubbles
14	Mon 04/24/2017 Thu 04/27/2017	- Rotating flows: Taylor columns - Eckman layers - Experimental techniques: hot wires - high speed imaging
15	Mon 05/01/2017 Thu 05/04/2017	- Experimental techniques: Particle Image Velocimetry - Laser Induced Fluorescence - Lab experiments: Hot wire calibration and measurements
16	Mon 05/08/2017 Thu 05/11/2017	- Lab experiments: Particle Image Velocimetry experiments - Lab experiments: Particle Image Velocimetry post processing
17	Mon 05/15/2017 Thu 05/18/2017	- Oral presentations - Final exam
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Note

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