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

Course Syllabus: Hydrodynamic Stability - ME 306

Division	Physical Science and Engineering Division
Course Number	ME 306
Course Title	Hydrodynamic Stability
Academic Semester	Fall
Academic Year	2019/2020
Semester Start Date	08/25/2019
Semester End Date	12/10/2019
Class Schedule (Days & Time)	09:00 AM - 10:30 AM | Tue Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Ravindra Samtaney	ravi.samtaney@kaust.edu.sa	+966128082958		By appointment

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	Students will learn the concept of stability of fluid flows. We will examine in detail two types of stability analysis: normal modes method and treating the stability problem as an initial value problem. We will examine the details of linearizing the governing equations. Several instabilities will be examined: Rayleigh-Taylor, Jeans instability, Rayleigh-Benard convection, Kelvin-Helmholtz instability, Richtmyer-Meshkov instability. Several stability criteria will be discussed. Parallel shear flows along with derivations of Rayleigh and Orr-Sommerfeld equations and discussion of algebraic growth. Students will learn numerical techniques for computationally determining stability including the novel use of numerical inverse Laplace Transforms. Introductory global stability analysis will be discussed.
Course Description from Program Guide	
Goals and Objectives	Students will learn the concept of stability of fluid flows. We will examine in detail two types of stability analysis: normal modes method and treating the stability problem as an initial value problem. We will examine the details of linearizing the governing equations. Several instabilities will be examined: Rayleigh-Taylor, Jeans instability, Rayleigh-Benard convection, Kelvin-Helmholtz instability, Richtmyer-Meshkov instability. Several stability criteria will be discussed. Parallel shear flows along with derivations of Rayleigh and Orr-Sommerfeld equations and discussion of algebraic growth. Students will learn numerical techniques for computationally determining stability including the novel use of numerical inverse Laplace Transforms. Introductory global stability analysis will be discussed.
Required Knowledge	Graduate level fluid mechanics. Linear algebra. Complex analysis.

Reference Texts	-Hydrodynamic Stability Drazin and Reid (Author) **Publisher:** Cambridge (2010) -Hydrodynamic and Hydromagnetic Stability Chandrasekhar (Author) International Series of Monographs on Physics(1981) -Theory and Computation of Hydrodynamic Stability Crimnale, Jackson and Joslin (Author) Cambridge Monographs on Mechanics (2003) -Stability and Transition in Shear Flows Shmid and Henningson (Author) Springer (2001)
Method of evaluation	**30.00**% - Course Project(s) **30.00**% - Midterm exam **10.00**% - Homework /Assignments **30.00**% - Final exam
Nature of the assignments	Papers will be assigned every week for reading. Students will be required to present a 5-minute summary of papers read in class. Homeworks will be derivation based and meant to strengthen concepts learned in class. An independent stability project will be required; for this a proposal will have to be submitted in the 5th week of class.
Course Policies	All students are expected to attend every lecture
Additional Information	Some notes and homework including solutions will be posted on the blackboard. All communications regarding the class will be on the blackboard and via email. All students are supposed to work independently on homework assignments.

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Tue 08/27/2019	Basic review of fluid dynamics
1	Thu 08/29/2019	Introduction to Stability
2	Tue 09/03/2019	Jeans Gravitational Instability
2	Thu 09/05/2019	Rayleigh-Taylor Instability
3	Tue 09/10/2019	Linearization, Normal Mode Analysis, Dispersion Relations
3	Thu 09/12/2019	Rayleigh-Benard Thermal Instability
4	Tue 09/17/2019	Exchange of Instabilities
4	Thu 09/19/2019	A Variational Principle for Convection
5	Tue 09/24/2019	No classes
5	Thu 09/26/2019	Stability of Inviscid Parallel Flows
6	Tue 10/01/2019	Rayleigh Inflection Point Theorem
6	Thu 10/03/2019	Fjortoft’s Criterion, Howard Semi-circle Theorem
7	Tue 10/08/2019	Kelvin Helmholtz Instability
7	Thu 10/10/2019	Midterm I
8	Tue 10/15/2019	Critical Layers
8	Thu 10/17/2019	Stability of Non-inflectional Profiles
9	Tue 10/22/2019	Couette Flow as an Initial Value Problem
9	Thu 10/24/2019	Algebraic Growth
10	Tue 10/29/2019	Stability of Parallel Viscous Flows: Squire Theorem
10	Thu 10/31/2019	Orr-Sommerfeld Equation
11	Tue 11/05/2019	Plane Poisseulle Flow
11	Thu 11/07/2019	Boundary Layer Instability
12	Tue 11/12/2019	Stability of Open Flows
12	Thu 11/14/2019	Concept of Wave Packets Transient Dynamics
13	Tue 11/19/2019	Global Stability Analysis
13	Thu 11/21/2019	Computing global eigenspectra
14	Tue 11/26/2019	Richtmyer-Meshkov Instability
14	Thu 11/28/2019	Numerical inverse Laplace transform
15	Tue 12/03/2019	Numerical method to solve IVP
15	Thu 12/05/2019	Project Presentation
16	Tue 12/10/2019	Exams

Note

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