Department of Mathematics
National Institute of Technology Jamshedpur
(An Institute of National Importance under MHRD, Govt. of India)

Date: 7 January, 2020

SPRING SEMESTER 2019-20
Course Handout

Course title: Fluid Dynamics | **Semester:** Even (Spring)
Course Code: MAG 6134 | **Credit:** 4 (4-0-0)
Instructor In-charge: Dr. Raj Nandkeolyar

Scope & Expected Outcome:

The course is aimed at providing an in-depth knowledge of the fundamental concepts of topics in fluid mechanics to a standard where the student will be able to apply the techniques in deriving a range of important results and in research problems relating to fluid dynamics. After completing this course, students will be able to understand the basic principles of fluid mechanics, such as Lagrangian and Eulerian approach, conservation of mass etc, rotationality of fluid flow, Bernoulli's equation etc. They will also be able to analyse simple fluid flow problems (flow between parallel plates, flow through pipe etc.) with the help of Navier - Stoke's equation of motion, and understand the important concepts related to boundary layer theory.

Syllebus:

Equations of motion for viscous fluid, similarity of flows, Reynolds number, flow between parallel flat plates, steady flow in pipes, flow between two concentric cylinders, Application of parallel flow theory, unsteady flow over a flat plate, boundary layer concept, boundary layer equations in two-dimensional flow, Boundary layer flow along the flat plates: Blasius solution, shearing stress and boundary layer thickness, boundary layer on a surface with pressure gradient, Momentum integral theorems for boundary layer, the Von Karman integral relation, application of momentum integral equation to boundary layers: Von Karman-Pohlhausen method, separation of boundary layers, boundary layer control, methods of boundary layer control, Introduction to turbulent flow, origin of turbulence, Reynolds' modification of Navier-Stoke's equations for turbulent flow, Semi-empirical theory of turbulence.

Text Books & Reference Books:

- An Introduction to Fluid Dynamics by G. K. Batchelor, Cambridge University Press.
- A textbook of Fluid Dynamics by F. Chorlton, CBS Publishers.
- Fluid Dynamics-Fundamentals and Applications by Y. A. Cengel and J. M. Cimbala, McGraw Hill Education.

Tentative Course Plan:

Table 1: **Tentative Course Plan**

S.No.	Topics to be covered	Expected No. of lectures
1	Introduction and motivation of the course.	1
2	Basic properties of fluids: density, pressure, temperature, thermal conductivity, Classification of fluid flows: viscous and inviscid flows, internal and external flows, compressible and incompressible flows, laminar and turbulent flows, natural and forced flow, steady and unsteady flow.	2
3	System and control volume, importance of dimensions and units, viscosity of the fluid, visualization of boundary layer.	1
4	Kinematics of fluids: Lagrangian and Eulerian description of fluid flow, acceleration field, material acceleration, local acceleration, convective acceleration, and material derivative, the conversion of Lagrangian to Eulerian and Eulerian to Lagrangian.	2
5	Streamlines, streamtubes, streaklines, and pathlines and their equations.	1
6	State of stress at a point, traction vectors, components of stress tensor, representation of state of stress at a point of an arbitrarily oriented body in terms of stress components, Cauchy theorem.	2
7	Strain rates: linear strain rate, volumetric strain rate, conservation of mass in terms of volumetric strain rate, incompressible flow, variable density incompressible flow, conservation of mass by control volume approach, rate of shear strain, angular velocity, vorticity, irrotational and rotational flow, stream function, velocity potential.	3
8	Equations of motion for fluid flow, similarity of flows, Reynolds number.	5
9	Flow between parallel flat plates, steady flow in pipes, flow between two concentric cylinders.	4
10	Application of parallel flow theory, unsteady flow over a flat plate, boundary layer concept, boundary layer equations in two-dimensional flow, Boundary layer flow along the flat plates: Blasius solution	5
11	Shearing stress and boundary layer thickness, boundary layer on a surface with pressure gradient, Momentum integral theorems for boundary layer, the Von Karman integral relation, application ion of momentum integral equation to boundary layers: Von Karman-Pohlhausen method	7
12	Separation of boundary layers, boundary layer control, methods of boundary layer control.	5
13	Introduction to turbulent flow, origin of turbulence, Reynolds' modification of Navier-Stoke's equations for turbulent flow, Semi-empirical theory of turbulence.	7
	Total Number of Lectures	**45**

Evaluation Scheme:

Table 2: **Evaluation Scheme**

Evaluation Component	**Duration**	**Weightage**	**Date and Time**
Mid Sem Exam	2 hour	30	As per Academic Calendar
End Sem Exam	3 hour	50	As per Academic Calendar
Internal Assessment	N/A		Notified Whenever Required
Class Test		10	
Assignment		5	
Teacher's Assessment		5	

Note:

- All notices regarding the course will be displayed on the Notice Board of Department of Mathematics.
- **Students may be required to give a short presentation** (in MS PPT or LaTeX Beamer) on a topic taught in the course and the **performance will play a major role during evaluation of Internal Assessment Marks.**

Instructor In-charge

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