



Course Handout (Part II)

Date: 23/7/2016

Course No. MATH F445
Course Title Mathematical Fluid Dynamics
Instructor-in-Charge ASHISH TIWARI

- 1. Scope & Objective of the Course** This course is an introduction to the field of fluid dynamics. The objective of the course is to present some of the basic ideas of fluid dynamics in a mathematically attractive manner (which does not mean “fully rigorous”); the physical background and motivation for some constructions that have been used in recent mathematical and numerical work on the Navier–Stokes equations; and to grow interest among the students in this beautiful and difficult subject.
- 2. Text Book**
 - i. Introduction to Mathematical Fluid Dynamics, R. E. Meyer, Dover Publisher, 2007(4th Edition),**
 - ii. Fluid Mechanics, P.K.Kundu & I.M.Cohen, 3rd Edition, Elsevier, 2005.**
- 3. Reference Books**
 - i.** Mathematical Introduction to Fluid Mechanics by Chorin, Springer-Verlag, Fourth Edition, 2000.
 - ii.** A Text Book of Fluid Dynamics, F. Charlton, CBC, Reprint 1998.
 - iii.** Computational Fluid Dynamics: The Basics with Applications, J.D. Anderson, Jr, McGraw Hill International Edition, 1995.
 - iv.** Boundary-Layer Theory, H Schlichting, K. Gersten, Springer, 1999.
 - v.** A Treatise on Hydrodynamics, W. H. Besant and A. S. Ramsey, CBS Publishers, Delhi, 1988.

4. Course Plan			
Lec. No.	Learner's Objective	Topic to be Covered	Reference (Text Book)
1-6	Introduction to the Fluid Dynamics and Fundamental Concepts, Different Approaches to Analyze Fluid Motion and Their Equivalence	Introduction, Solids, Liquids, and Gas, Lagrange and Eulerian Descriptions, Continuum hypothesis, Conservation of Mass based on Finite Control Volume Fixed in Space and Moving with the Fluid and hence their equivalence, Equation of Continuity in Cylindrical and Spherical Coordinates,	T1: 1-4 T2: 1.1-4, 3.2-3, 4.1-4.3, Appendix-B1 & B3
7-13	Potential Flows and its characteristics	Potential Flow, Laplace Equation, Streamline, Pathline and Streakline, Streamfunction, Vorticity, Line Vortex, Vortex Sheet, one-, two- and three-dimensional flow, Sources and Sink, Doublet, Complex Potential of Source and Doublet, Flow and Circulation	T1: 5-9, T2: 3.4, 3.12-13, 6.2, 6.5-7
14-17	Conservation Laws for Inviscid Flows	Conservation of Linear Momentum, Euler's Equation in Different Coordinate Systems, Bernoulli's equation and its application,	T1: 10-12, 15 T2: 4.16-17



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18-24	Conservations of Momentum and Energy	Constitutive equations for Newtonian Fluid, Navier-Stokes Equations in different coordinate systems, First Law of Thermodynamics, Boundary Conditions, Boussinesq approximation.	T1:17-19,33,35,38 T2: 4.10-11, 4.14, 4.18-19
25-30	Fluid of Small/High Viscosity, Laminar Flows	Reynolds number, High and Low Reynolds number Flows, Dimensional Analysis, Exact Solution of Navier-Stokes Equation: Couette-Poiseuille Flows, Stokes' Creeping Flows around a Sphere, A singular perturbation example	T1: 20-21 T2:8.2-5,9.4-9.7, 9.11-12
31-33	Boundary Layers	Introduction, Boundary Layer Approximations, Setting up the Boundary-Layer Equations, Different measure of Boundary Layer Thickness	T2:10.1-3 ,
34-40	Limiting cases of Boundary Layer Flows	Limit Equation for the Flat Plate with a sing at the leading edge, Discussion of Blasius' Equation, Similarity Solution, Effect of Pressure Gradient, Separation, Wake, Description of Flow Past a Circular Cylinder , Decay of A Laminar Shear Layer	T1: 23, 25, 27-28 T2:10.4-9, 10.17

5. Evaluation Scheme:

Component	Duration	Weightage	Date	Remarks
Mid Term Exam	90 Min	30%	3/10 10:00 - 11:30 AM	CB
Comprehensive Examination	3 Hours	40%	1/12 FN	CB/OB (details will be announced in class)
Quizzes/Assignments	30 Min	30%	***	CB/OB

*** To be announced later.

7. Notices: All notices regarding the course MATH F445 will be put on online notice (NALANDA) and Mathematics department notice board.

8. Make up Policy: For mid-semester and comprehensive examinations, make up will be given only in genuine cases and for that prior permission has to be obtained. For quizzes/assignments, there will be no make up in any circumstances.

9. Chamber consultation hours: To be announced in the class.

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