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**FIRST SEMESTER 2019-2020**

# *Course Handout Part II*

**Date: 15/07/2019**

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

*Course No.* : ME G621

## Course Title : Fluid Dynamics

## Instructor-in-Charge : K. Ram Chandra Murthy

**Scope and Objective of the Course:**

The objective of this course is to lay strong foundation in understanding the concepts on turbulence and the statistical and computational methods used in estimating it. Starting from the basics of laminar flow concepts, the key parameters of turbulence is explained with the help of equations of motion. This course focuses also on fundamentals of compressible flow viz isentropic flow, shock waves, Prandtl-Meyer expansions. The fundamental mathematics and physics governing these flows are derived and discussed.

**Text Book (TB):**

1. Garde R. J., *Turbulent Flow*, New Age International Pvt. Ltd., New Delhi, 3rd Ed., 2010.
2. Yahya S. M., *Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion*, New Age International Pvt. Ltd., New Delhi, 4th Ed., 2010.

**Reference Book (RB):**

1. John D. Anderson Jr., *Modern Compressible Flow - With Historical Perspective*, McGraw-Hill Publishing Company, Singapore, 2nd Ed., 1990.
2. Stephen B. Pope, *Turbulent Flows*, Cambridge University Press, 2000.

**Course Plan:**

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| --- | --- | --- | --- |
| **Lecture No.** | **Learning objectives** | **Topics to be covered** | **Chapter/**  **Section** |
| 1-4 | Laminar Flow | Introduction, Equations of motion, Conditions of Similarity, Creeping motion, Exact solutions of N-S equations, Boundary layer approximations, Characteristics of laminar flows | TB:1  Chapter: 1 |
| 5-7 | Transition from Laminar to Turbulent Flow | Concept of Stability, Stability analysis, Experimental verification, Factors affecting transition | TB:1  Chapter: 2 |
| 8-11 | Nature of Turbulence | Averaging procedures, Characteristics of turbulent flows, Types of turbulent flows, Scales of turbulence, Methods of analysis | TB:1  Chapter: 3 |
| 12-14 | Equations of Motion | Reynold’s equation of motion, Energy Equation, Bernoulli’s equation for mean flow | TB:1  Chapter: 4 |
| 15-20 | Statistical Theory of Turbulence | Introduction & some definitions, Isotropic turbulence and homogeneous turbulence, Kinematics & dynamics of isotropic turbulence, Spectrum analysis, Kolmogorov’s theory of local isotropy | TB:1  Chapter: 5 |
| 21-24 | Turbulence Models | Mixing length hypothesis, Karman’s similarity hypothesis, Vorticity transport theory, Zero equation models, One equation models, Two equation models, Multi-equation models | TB:1  Chapter: 6 |
| 25-27 | Introduction to Compressible flow | Definitions, Basic relations, Energy equations | TB:2  Chapters: 1&2 |
| 28-29 | Rate Equations | Rate equations for a control volume | TB:2  Chapter: 3 |
| 30-32 | Isentropic Flow with Variable Area | Stagnation and critical states, Flow through nozzles and diffusers, Use of gas tables | TB:2  Chapter: 4 |
| 33-36 | Flow with Normal Shock Waves | Governing equations, Prandtl-Meyer Relation, Rankine-Hugoniot equations, Strength of a shock wave, Moving normal shock waves | TB:2  Chapter: 6 |
| 37-39 | Flow in Constant Area Ducts with Friction | Fanno curves, Fanno flow equations and their solutions, Variation of Mach number with duct length, Isothermal flow with friction | TB:2  Chapter: 8 |
| 40-42 | Flow in Constant Area Ducts with Heat Transfer | Rayleigh line, Rayleigh flow relations, Maximum heat transfer | TB:2  Chapter: 9 |

**Evaluation Scheme:**

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| --- | --- | --- | --- | --- |
| **Component** | **Duration** | **Weightage (%)** | **Date & Time** | **Nature of Component** |
| Assignments | - | 10 | To be announced in the class | Open Book |
| Lab Reports & Viva | - | 15 | To be announced in the class | Open Book |
| Project Seminars (Mid- & End-sem) | - | 20 | To be announced in the class | Open Book |
| Midsem Test | 90 | 20 | 03/10 , 11:00 – 12:30 pm | Closed Book |
| Compre | 180 | 35 | 09/12 AN | Closed Book |

**\*List of Experiments:**

**1.** Free and forced vortex flow

2. Reynold’s and laminar flow

3. Boundary layer flow

4. Nozzle performance test

5. Nozzle pressure distribution test

**Chamber Consultation Hour**: To be announced in the class.

**Notices:** All notices concerning this course will be displayed in *CMS (institute’s web-based Course Management System)*. Students are advised to visit *CMS* regularly for all notices and updates.

**Make-up Policy:** Make-up request for tests shall be granted only for the *genuine* case with sufficient evidence. Request letter duly signed by the student must reach the undersigned at least one day before the scheduled test.

**Academic Integrity Policy:**  It is expected that in compliance with institute rules and regulations, academic integrity should be adhered to in all the evaluation components. No type of academic dishonesty is acceptable and malpractice in any form will have serious implications.

**INSTRUCTOR-IN-CHARGE (ME G621)**