BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE-PILANI - HYDERABAD CAMPUS

INSTRUCTION DIVISION, FIRST SEMESTER 2016 - 2017

(COURSE HANDOUT PART II)

Date: 02/08/2016

In addition to part-I (general handout for all courses in the time-table), this handout provides the specific details regarding the course.

Course No.: ME G621

Course Title: FLUID DYNAMICS

Instructors: N. Jalaiah, K. Supradeepan

Instructor-in-charge: N. JALAIAH

1. **Course Description**: Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory; flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

2. **Scope and Objective:** 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.

3. **Text Book**:

   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 Books:

   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.

4. **Course Plan**:

Lecture Nos.	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

Lecture Nos.	Learning Objectives	Topics to be covered	Chapter/ Section
25-26	Introduction to Compressible flow	Definitions, Basic relations, Energy equations	TB:2 Chapters: 1&2
27	Rate Equations	Rate equations for a control volume	TB:2 Chapter: 3
28-30	Isentropic Flow with Variable Area	Stagnation and critical states, Flow through nozzles and diffusers, Use of gas tables	TB:2 Chapter: 4
31-34	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
35-37	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
38-40	Flow in Constant Area Ducts with Heat Transfer	Rayleigh line, Rayleigh flow relations, Maximum heat transfer	TB:2 Chapter: 9

5. Evaluation Scheme:

Evaluation Component	Duration	Weightage (%)	Date & Time	Nature of Component
Test-1	60 min	15	13.09.2016 1.00 – 2.00 PM	**CB**
Test-2	60 min	15	21.10.2016 1.00 – 2.00 PM	**CB**
Lab Reports*	---	10	Continuous	OB
Project Report	---	20	To be announced in the class	OB
Seminar	---	10	To be announced in the class	OB
Comprehensive Exam	3 hours	30	08.12.2016 FN	**CB**

*** 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

6. Chamber Consultation Hour: To be announced in the class room.

7. Notices: All notices concerning this course shall be posted at **CMS**, the institute's web based course management system.

8. Make-up Policy: Make-up shall be given only to the genuine cases with prior intimation.

Instructor-in-charge
ME G621