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**FIRST SEMESTER 2022-2023**

# Course Handout Part II

Date: 11-08-2023

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

**Course No : AN F311 (3 0 3)**

**Course Title : Principles of Aerodynamics**

**Instructor-in-charge : Dr. Pardha Saradhi**

**Instructors : Dr. Pardha Saradhi**

**Scope and objective of the course**:

This course covers the first hand fundamentals about aerodynamics, i.e. the study of the flow of air about a body more specifically of an airplane, but much of the aerodynamics in this course is relevant to a wide variety of applications from sail boats to automobiles to birds. This course extends fluid mechanic concepts to the aerodynamic performance of wings and bodies in sub/supersonic regimes.

The students will be able to formulate and apply appropriate aerodynamic models to predict the forces on and performance of realistic three-dimensional configurations; assess the applicability of aerodynamic models to predict the forces on and performance of realistic three-dimensional configurations and estimate the errors resulting from their application; and be able to Perform a computational and experimental aerodynamic analysis and design.

**Course Pre/Co- requisite** (if any)**& Catalogue / Bulletin Description:** *ME F212 (Fluid Mechanics)*

**Text Books:**

TB 1: Anderson, J. D., Jr., *Fundamentals of Aerodynamics*, Tata McGraw Hill 2001.

**Reference books:**

RB 1: Bertin, J. J., *Aerodynamics for Engineers*, Pearson Education, 2002.

**Course plan#:**

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| --- | --- | --- | --- | --- |
| **Sl. No.** | **Learning objectives** | **Contents** | **Textbook**  **(TB 1) Chapter No.** | **No. of lecture(s)** |
| 1 | Introduction | Airfoils, wings and their nomenclature; lift, drag and pitching moment coefficients; centre of pressure and aerodynamic center, flow similarity, types of flows | Ch. 1 | 1-5 |
| 2 | Fundamental Principles | Scalar and vector fields, velocity potential, line, surface and volume integrals, mass, momentum and energy equation | Ch. 2 | 6-11 |
| 3 | Inviscid Incompressible Flow | Bernoulli’s equation, Laplace Equation, Uniform flows, Source and Sink, Flow over different bodies, , circulation and lift generation, Kutta-Joukovskii theorem | Ch. 3 | 12-16 |
| 4 | Incompressible Flow over Airfoils and Finite Wings | Airfoil nomenclature and characteristics, Airfoil Theory, Kutta Condition, Classical Thin Airfoil Theory, Finite Wing characteristics, Biot-Savart Law, Helmholtz Theorem, Prandtl’s Theory | Ch. 4-5 | 17-24 |
| 5 | Compressible flow | Method of superposition, thin airfoil theory, source and vortex methods. Subsonic compressible flow past airfoils; Critical Mach number, drag divergence Mach number, supercritical airfoils, effect of sweep, area rule. | Ch.7 | 25-30 |
| 6 | Subsonic Compressible Flow | Full and perturbation velocity potential formulations; Supercritical Airfoils, Prandtl and Glauert compressibility corrections. | Ch. 11 | 31-33 |
| 7 | Transonic and Supersonic Flow | Transonic flow past airfoils, transonic similarity rules; Supersonic flow past airfoils, linearised supersonic flow, shock expansion method. | Ch. 12 | 34-36 |
| 8 | Hypersonic Flow | Hypersonic flows, real gas effects, Newtonian theory, lift and drag in hypersonic flows. | Ch. 14 | 37-38 |
| 9 | Viscous Flow | Qualitative aspects, NS Equation, Viscous Flow Energy Equation, Boundary Layer Theory, | Ch. 15, 17 | 39-42 |

**Evaluation Scheme:**

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| **Component** | **Duration**  **(min.)** | **Weightage (%)** | **Date & Time** | **Nature of Component** |
| Mid sem | 90 Min. | 30% | 14/10 - 4.00 - 5.30PM | Close book |
| Compre | 180 Min. | 40% | 21/12 AN | Close book |
| Assignments |  | 15% | Will be announced in class | Open book |
| Project |  | 15% | Will be announced in class | Open Book |

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

**Notices:** All notices concerning this course shall be communicated only through **CMS** (theinstitute’s web based course managementsystem) students are advised to visit CMS regularly for latest updates.

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

**Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**INSTRUCTOR-IN-CHARGE**