

High Speed Aero Dynamics - Web course

COURSE OUTLINE

The course is designed as a core course for the undergraduate students of Aerospace engineering and contains the basic material essential for a foundation of compressible flow aerodynamics.

The course introduces the fundamental concepts and principles of compressible flow and intends to provide the necessary background for advanced studies on the subject.

A number of application problems are incorporated to illustrate the concepts. The course covers the general principles and essentials of compressible flow, the flow equations, one-dimensional gas dynamics.

Wave motion and waves in supersonic flow, flow in ducts, small perturbation theory, method of characteristics and similarity rules.

The exercises included in the course are intended to demonstrate the use of the course material and to outline additional equations and results.

Even though the course is prepared mainly for the use of undergraduate students in aerospace engineering, it will also be useful to graduate students, teachers and practicing engineers and scientists.

Contents:

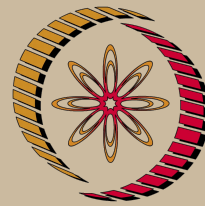
Basic concepts of compressible flow, Governing equations of compressible flow, One-dimensional gas dynamics, Normal shock.

Linear and nonlinear wave motion, Flow in ducts, Oblique shock and expansion, Interaction of waves.

Shock-expansion theory, Small disturbance theory, Linearized subsonic and supersonic flow, Method of characteristics, The similarity rules of high-speed flow and determination of critical Mach number of transonic flow.

COURSE DETAIL

S.No	Topics	No.of Hours
1	Basic concepts of compressible flow continuity, energy and momentum equations. Onedimensional inviscid flow; Stagnation quantities; Isentropic conditions. Speed of sound and Mach number; Isentropic relations; Area-velocity relation.	6
2	Flow through constant area duct; Normal shock; Propagating Normal Shock.	2
3	Onedimensional linear and nonlinear wave motion; Linear and Nonlinear Shock tube.	5



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Aerospace Engineering

Pre-requisites:

1. Fluid Mechanics/Introduction to Aerodynamics, Engineering Thermodynamics, Low Speed Aerodynamics.

Coordinators:

Dr. K.P. Sinhamahapatra
Department of Aerospace Engineering IIT Kharagpur

4	<p>Oblique shock and supersonic compression by turning.</p> <p>Weak shocks and Mach waves; Supersonic expansion by turning.</p> <p>Prandtl-Meyer expansion fan; Reflection and intersection of shocks.</p> <p>Shock detachment and bow shock; Shock Expansion theory with application to thin airfoils.</p>	6
5	<p>Flow through converging and converging diverging ducts.</p> <p>Flow through constant area duct with friction (Fanno flow) and Flow through constant area duct with heat addition (Rayleigh flow).</p>	7
6	<p>Relation between vorticity and entropy-Crocco's equation.</p> <p>Compressible potential flow; Potential and Stream functions.</p> <p>Linearized subsonic and supersonic flow theory.</p> <p>Small Perturbation Equation- Subsonic, Supersonic and Transonic flows.</p> <p>Ackeret's problem; Supersonic thin airfoil theory.</p>	6
7	<p>Slender body theory; Singularity solutions; Affine transformation.</p>	2
8	<p>Method of characteristics; Compatibility equations and method of solutions for isentropic and non-isentropic flows; Method of finite waves.</p>	3
9	<p>Similarity rules for subsonic, supersonic and transonic flows; Critical Mach number of an airfoil.</p>	3
	Total	40

References:

1. A H Shapiro, Dynamics and Thermodynamics of Compressible Fluid Flow - Volume I & II, Ronald Press.
2. H W Liepmann and A Roshko, Elements of Gas Dynamics, John Wiley & Sons.
3. J D Anderson, Jr., Modern Compressible Aerodynamics, McGraw Hill International.