FUNDAMENTALS OF COMPRESSIBLE FLOW

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TYPE OF COURSE : New | Core | UG/PG
COURSE DURATION : 8 weeks (20 Jul' 20 - 11 Sep' 20)
EXAM DATE : 27 Sep 2020

PRE-REQUISITES : Fundamentals of "Fluid Mechanics and Thermodynamics"

INTENDED AUDIENCE : Undergraduate and Postgraduate students of Mechanical and Aerospace Engineering; Faculty member associated with Mechanical/Aerospace Streams; Practicing engineers and Scientists in Aeronautics and Space Technology

INDUSTRIES APPLICABLE TO : Practicing Engineers, Scientists in Aeronautics and Space Technology, Researchers working in the area of "Compressible Flow" will be benefited from this course.

COURSE OUTLINE :

Gas Dynamics is a subject of fundamental interest to Mechanical and Aerospace engineers that provides a link between fundamental subjects i.e. "Fluid Mechanics and Thermodynamics". It pertains the basic theory of compressible flow, formation of shock waves and expansion waves, nozzle flows.

ABOUT INSTRUCTOR :

Prof. N. Sahoo has been affiliated to the Department of Mechanical Engineering at IIT Guwahati since 2004. His broad research interest include Fluid Mechanics, Thermodynamics and Heat Transfer. He has undertaken various interdisciplinary courses within Department and NPTEL platform. Besides, he has published several research papers in peer-reviewed International Journals and Conferences. He gas guides several PhD scholars.

COURSE PLAN :

Week 1**:** Review Concepts of Fluid Mechanics and Thermodynamics:Introduction to fluids, Concepts of continuum, Forces acting on the fluid, Description of fluid motion, Kinematic properties of fluid, Review and fundamental aspects of Thermodynamics

Week 2**:** Wave Propagation in Compressible Medium: Introduction to compressible flow, Governing equations for one dimensional flow, Acoustic speed and Mach number, Stagnation and characteristics properties, Flow Regimes, Mach waves, Pressure disturbances in compressible fluid, Development of compression and expansion waves

Week 3**:** Quasi-One Dimensional Isentropic Flow:Governing Equations, Area-velocity relation and isentropic flow through variable area ducts, Concepts of nozzle and diffuser for compressible flow, Convergent-Divergent nozzle, Subsonic flow in a convergent-divergent nozzle

Week 4**:** Normal Shock Waves: One-dimensional equations for stationary normal shock, Entropy change across a normal shock, Crocco's Theorem, Hugoniot equation, Moving normal shock and reflected shock waves

Week 5**:** Expansion Waves and Oblique Shocks: Two-dimensional waves, Flow equations for Prandtl-Meyer expansion fan, Equation of motion for straight oblique shock wave, Oblique shock relations, Concepts of attached and detached shock waves

Week 6**:** Intersection of Shocks and Expansion Waves: Reflections and Intersections of Shocks and Expansion Waves, Supersonic flow in a convergent-divergent nozzle.

Week 7**:** Compressible Flow with Friction and Heat Transfer: Flow in a constant area duct with friction, Fanno line flow and its working relations, Flow with heating and cooling in a constant area duct, Rayleigh flow and its working relations

Week 8**:** Measurement Diagnostics and Experimental Facilitates for Compressible Flow: Pressure and temperature measurements, Concepts of flow visualization, Introduction to high speed wind tunnels, shock tubes and shock tunnels