AERODYNAMICS-II

V Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
A5AE18	PCC	3	0	0	3	30	70	100

COURSE OBJECTIVES:

Students undergoing this course are expected:

- To familiarize the features of inviscid compressible flows, including shock and expansion waves and the governing differential equation of motion of steady compressible flows
- To familiarize the estimation of the lift and drag for basic aerodynamic shapes in compressible in viscid flows and the importance of compressibility effects in wind tunnel design

UNIT-I ONE DIMENSIONAL FLOWS

Compressibility, Review of Fundamentals: Concepts from Fluid Mechanics, Basic Thermodynamic Relations. Velocity of sound. Mach number, isentropic flows. Governing equations for inviscid compressible flow- Applications of Continuity, Momentum and Energy equation, Stagnation conditions, Alternative forms of energy equation

UNIT-II SHOCKS AND EXPANSION WAVES

Basic equations, relations across a normal shock, Calculation of normal shock wave properties, measurements of airspeed in subsonic and supersonic flows. Entropy rise across normal shock and its relation to pressure rise, Numerical exercises with normal shock tables.

Oblique shock relations. Supersonic Mach number relations strong and weak shock solutions / Shock flow over a wedge polar. Regular reflection from a solid boundary. Intersections of shock wave. Expansion waves. Prandtl – Meyer Expansion. Shock Expansion theory

UNIT-III FLOW THROUGH NOZZLES AND DUCTS

Flow Through a nozzle: Convergent Nozzles, CD Nozzles, Exit Pressure variation vs Stagnation pressure variation. Chocked flow conditions. Normal shock. Under and over expansion conditions. Flow through diffusers, wave reflections from a free boundary, Hugoniot Equation, Definition of Fanno and Rayleigh lines.

UNIT-IV HYPERSONIC FLOWS

Introduction, Qualitative aspects of hypersonic flows, Applications of Hypersonic flow, Basic hypersonic shock relations, Hypersonic shock relation in terms of hypersonic similarity parameters, Examples related to Hypersonic Flow, Hypersonic expansion wave relation. Newtonian flow model, Modified Newtonian flow, Wave riders.

UNIT-V FLOW MEASUREMENTS AND MODEL TESTING

Non dimensional parameters and numbers Similarity of flows, Wind tunnel, types of wind tunnels, description of subsonic, supersonic, hypersonic wind tunnel, Model testing in wind tunnels. Pressure, Velocity measurements, Force measurements-Wind tunnel balances, Scale effects and corrections, wall interferences, Shock Tube, Supersonic Wind tunnel, Flow visualization.

Text Books:

1. Anderson J .D. (2011), Modern Compressible flows with Historical Perspective, 5th edition, McGraw-Hill, New Delhi.
2. Rathakrishnan E.E. (2010), Gas Dynamics, 3rd Edition, Prentice Hall of India, New Delhi

Reference Books:

1. A.H.Shapiro, The Dynamics And Thermodynamics Of Compressible Fluid, Volume -1,
2. JJ. Bertin, Aerodynamics for Engineers, 5th edition, Pearson

COURSE OUTCOMES:

At the end of the course the students are able to:

1. Formulate and predict the aerodynamic characteristics of a body in supersonic flows
2. Obtain analytical solution for the supersonic flows over different bodies
3. Evaluate the flow through nozzles and ducts of varying areas
4. Analyse shock waves in terms of hypersonic flows.
5. Demonstrate flow measurements model testing in wind tunnels