

AE6503 AERODYNAMICS – II

DETAILED SYLLABUS

OBJECTIVES:

- To introduce the concepts of compressibility,
- To make the student understand the theory behind the formation of shocks and expansion fans in Supersonic flows.
- To introduce the methodology of measurements in Supersonic flows.

UNIT I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW

Compressibility, continuity, momentum and energy equations for steady one-dimensional flow, compressible bernoulli's equation, area – mach number – velocity relation, mach cone, mach angle, one dimensional isentropic flow through variable area duct, critical conditions, characteristic mach number, area-mach number relation, maximum discharge velocity – operating characteristics of nozzles- introduction to hypersonic flows

UNIT II SHOCK AND EXPANSION WAVES

Normal shock relations, Prandtl's relation, Hugoniot equation, Rayleigh Supersonic Pitot tube equation, Moving normal shock waves, Oblique shocks, $\theta - \beta - M$ relation, Shock Polar, Reflection of oblique shocks, left running and right running waves, Interaction of oblique shock waves, slip line, shock-boundary layer interaction – transonic lambda shock – compression corner effect – incident shock interaction - Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simple and non-simple regions.

UNIT III TWO-DIMENSIONAL COMPRESSIBLE FLOW

Potential equation for 2-dimensional compressible flow, Linearisation of potential equation, perturbation potential, Linearised Pressure Coefficient, Linearised subsonic flow, Prandtl-Glauert rule, Linearised supersonic flow, Method of characteristics.

UNIT IV HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION

Critical Mach number, Drag divergence Mach number, Shock Stall, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock-expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircraft- aerodynamic heating.

UNIT V EXPERIMENTAL TECHNIQUES FOR HIGH SPEED FLOWS

Wind tunnels for transonic, Supersonic and hypersonic flows, shock tube, Gun tunnels- peculiar problems in the operation of hypersonic tunnels - Supersonic flow visualization methods

TEXT BOOKS:

1. Anderson, J. D, "Modern Compressible Flow", McGraw-Hill & Co., 2002.
2. Rathakrishnan. E, "Gas Dynamics", Prentice Hall of India, 2004.

REFERENCES:

1. Shapiro, A. H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald Press, 1982.
2. Zucrow, M. J. and Anderson, J. D., "Elements of Gas Dynamics", McGraw- Hill & Co., 1989.
3. Oosthuizen, P.H. & Carscallen, W.E., "Compressible Fluid Flow", McGraw- Hill & Co., 1997