5th Semester	RAE5C001	Aerodynamics – II	L-T-P 3-0-0	3 CREDITS

COURSE OUTCOMES

1. Understand and derive the one dimensional compressible flow equations
2. Understand the normal, oblique shocks, expansion waves and calculate the various flow properties across these waves
3. Develop the linearized differential equations of motion for steady compressible flows and different compressibility corrections
4. Understand the different air foil/wings design in high speed flows
5. To classify different types of high speed wind tunnels and their operations and also different optical technique for supersonic flow visualization

Module – I ONE DIMENSIONAL COMPRESSIBLE FLOW 10 hours

Energy, Momentum, continuity and state equations, velocity of sound, adiabatic steady state flow equations, Flow through convergent- divergent passage, Performance under various back pressures.

Module – II NORMAL, OBLIQUE SHOCKS 12 hours

Prandtl equation and Rankine – Hugonoit relation, Normal shock equations, Pitot static tube, corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, θ- β- M relation, Hodograph and pressure turning angle, shock polar, flow past wedges and concave corners, strong, weak and detached shocks,

Module – III EXPANSION WAVES, RAYLEIGH AND FANNO FLOW 8 hours

Flow past convex corners, Expansion hodograph, Reflection and interaction of shocks and expansion, waves. Method of Characteristics Two dimensional supersonic nozzle contours. Rayleigh and Fanno Flow

Module – IV DIFFERENTIAL EQUATIONS OF MOTION FOR STEADY COMPRESSIBLE FLOWS 7 hours

Small perturbation potential theory, solutions for supersonic flows, Mach waves and Mach angles, Prandtl-Glauert rule - affine transformation relations for subsonic flows, Linearized two dimensional supersonic flow theory - Lift, drag, pitching moment and center of pressure of supersonic profiles.

Module – V AIRFOIL IN HIGH SPEED FLOWS **7 hours**

Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects

Books

1. Rathakrishnan, E., "Gas Dynamics", Prentice Hall of India, 2003.

2. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald Press, 1982.

3.Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw-Hill Book Co., New York, 1989.

4.Anderson Jr., D., – "Modern compressible flows", McGraw-Hill Book Co., New York 1999.

Digital Learning Resources

Course Name:	High Speed Aero Dynamics
Course Link:	https://nptel.ac.in/courses/101/105/101105024/
Course Instructor:	Prof. Dr. K.P. Sinhamahapatra, IIT Kharagpur