FLUID DYNAMICS

Course Code: 15ME2301 **L P C**
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Course Outcomes: At the end of the course, the student will be able to

CO1: Analyze and apply the concepts of turbulent flow to solve the fluid flow problems.

CO2: Explain the concepts of boundary layer.

CO3: Classify the compressible fluid flows and discuss stagnation properties.

CO4: Solve nozzle, diffuser, and shock wave problems of compressible fluids.

CO5: Apply Prandtl, Rankine-Hugniot equations to solve oblique shock waves and discuss the Fanno curves.

UNIT-I (10-Lectures)

Characteristics of turbulent flow-Reynolds equations of motion-turbulence modelling – Boussinesq Eddy viscosity concept – Prandtl's mixing length concept –Vonkaman similarity concept – Prandtl's universal velocity distribution-Karman – Prandtl velocity distribution-power law for velocity in smooth pipes – Friction factor for smooth and rough pipes-Charts for friction factor in pipe flow.

UNIT-II (10-Lectures)

Navier – Stokes Equations of motion – boundary layer over a flat plate – thickness of boundary layer –Prandtl's boundary layer equation – Vonkarmann momentum equations – shear stress and drag force – laminar boundary layer – turbulent boundary layer –pressure distribution in the boundary layer –boundary layer separation – drag and lift force – lift on an airfoil.

UNIT-III (10-Lectures)

Wave propagation in an elastic solid medium – propagation of sound waves – Mach number – Mach angle – equation of sound wave.

Energy equation – energy equation for non-flow and flow processes – adiabatic energy equation – stagnation enthalpy - stagnation temperature - stagnation pressure – stagnation velocity of sound – reference velocities – Bernoulli's equation – effect of Mach number on compressibility.

UNIT-IV (10-Lectures)

Comparison of isentropic and adiabatic processes – Mach Number variation - expansion in nozzles – compression in diffusers – stagnation and critical states – area ratio as a function of mach number – impulse function - mass flow rate, flow through nozzles - convergent nozzles – convergent-divergent nozzles – flow through diffusers.

Development of a shock wave – rarefaction wave – governing equations, Fanno line, Rayleigh line -Prandtl-Meyer relation – Mach number downstream of the shock wave – static pressure ratio across the shock - temperature ratio across the shock – density ratio across the shock - stagnation pressure ratio across the shock.

UNIT-V (10-Lectures)

Nature of flow through oblique shock waves – fundamental relations - Prandtl's equation – Rankine-Hugoniot equation.

The Fanno curves – Fanno flow equations – variation of flow parameters.

TEXT BOOKS:

1. P.Balachandran, "*Engineering Fluid Mechanics"*, 1st Edition, PHI Learning Private Limited, New Delhi, 2012.
2. S.M. Yahya, "*Fundamentals of Compressible Flow With Aircraft And Rocket Propulsion (SI UNITs)"*, 3rd Edition, New Age International Publishers, New Delhi, 2003.

REFERRENCES:

1. Yunus A. Cengel and John M. Cimbala, "*Introduction to Fluid Fluid Mechanics"*, Tata McGraw-Hill, 2006.
2. S.W. Yuan, "*Foundations of Fluid Mechanics"*, Prentice-Hall, 1967.
3. Patrick H. Oosthuizen and William E. Carscallen, "*Compressible Fluid Flow"*, McGraw-Hill Companies, Inc., New York, 1997.