COURSE CODE	COURSE TITLE	L	T	P	C
1152AE110	BOUNDARY LAYER THEORY	3	0	0	3

Course Category:

Programme Elective

- **Preamble :**

This course gives fundamental knowledge on boundary layer theory.

- **Prerequisite Courses:**
  Fluid Mechanics
- **Related Courses:**
  Nil
- **Course Educational Objectives :**
  - To make the students understand the importance of viscosity and boundary layer in fluid flow.
  - To introduce the theory behind laminar and turbulent boundary layers.
- **Course Outcomes :**
  Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Outline the fundamental equations of viscous flow	K1
CO2	Find the solutions of viscous flow equations	K3
CO3	Find the solutions for laminar flow boundary layer equations	K3
CO4	Find the solutions for turbulent flow boundary layer equations	K3
CO5	Find the solutions for compressible flow boundary layer equations	K3

- **`Correlation of COs with POs:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			**H**				H				
CO2	H			**H**				H				
CO3	H			**H**				H				
CO4	H			**H**				H				
CO5	H			**H**				H				

H- High; M-Medium; L-Low

- **Course Content :**

UNIT I FUNDAMENTAL EQUATIONS OF VICOUS FLOW 8

Fundamental equations of viscous flow, Conservation of mass, Conservation of Momentum-Navier-Stokes equations, Energy equation, Mathematical character of basic equations, Dimensional parameters in viscous flow, Nondimensionalizing the basic equations and boundary conditions, vorticity considerations, creeping flow, boundary layer flow.

UNIT II SOLUTIONS OF VICOUS FLOW EQUATIONS 10

Solutions of viscous flow equations, Couette flows, Hagen-Poiseuille flow, Flow between rotating concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Creeping motion, Stokes solution for an immersed sphere, Development of boundary layer, Displacement thickness, momentum and energy thickness**.**

UNIT III LAMINAR BOUNDARY LAYER EQUATIONS 12

Laminar boundary layer equations, Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – boundary layer over a curved body-Flow separation- similarity solutions, Blasius solution for flat-plate flow, Falkner–Skan wedge flows, Boundary layer temperature profiles for constant plate temperature –Reynold's analogy, Integral equation of Boundary layer – Pohlhausen method – Thermal boundary layer calculations.

UNIT IV TURBULENT BOUNDARY LAYER EQUATIONS 8

Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations — Velocity profiles – Law of the wall – Law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient, Eddy Viscosity, mixing length , Turbulence modeling.

UNIT V COMPRESSIBLE BOUNDARY LAYERS 7

Compressible boundary layer equations, Recovery factor, similarity solutions, laminar supersonic Cone rule, shock-boundary layer interaction.

Total: 45 Periods

h. Learning Resources

i. Text Books:

1. White, F. M., Viscous Fluid Flow, McGraw-Hill & Co., Inc., New York., 1985

ii. References:

1. Schlicting, H., Boundary Layer Theory, McGraw-Hill, New York, 1979.
2. Reynolds, A, J., Turbulent Flows Engineering, John Wiley and Sons, 1980. "Spacecraft Mission Design", Charles D.Brown, AIAA Education Series, Published by AIAA, 1998