

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. SEMESTER: VII Aeronautical Engineering

Subject Name: **Viscous and Boundary Layer Theory**
(Department Elective - I)

Subject Code: **170106**

Teaching Scheme				Evaluation Scheme			
Theory	Tutorial	Practical	Total	University Exam (E)		Mid Sem Exam (Theory) (M)	Practical (Internal)
				Theory	Practical		
4	0	2	6	70	30	30	20

Sr. No	Course Content	Total Hrs.
1.	BASIC CONCEPTS OF VISCOUS FLOWS: Viscous flow characteristics, introduction to hydrodynamic and thermal boundary layer theory, governing equations with effect of viscosity, flow over the flat plate at zero incidence, boundary layer thickness, displacement thickness, momentum thickness, energy thickness, boundary layer equation and their general properties.	6
2.	SOLUTIONS TO BOUNDARY LAYER FLOWS: Flat plate at zero angle of incidence, method of exact solution-Blassius solution to boundary layer problems, Approximate solutions - Vonkarman solution to boundary layer flows over the flat plate, flow with pressure gradient, flow over a cylinder, plane Couette flow, circular Couette flow, flow between parallel plates, numericals	8
3.	THERMAL BOUNDARY LAYERS: Heat transfer from heated surface. Heat transfer from cold surface, thermal boundary layer growth over the hot and cold surface, flow over the flat plate with different flow conditions with heat transfer, exact and approximate solutions to thermal boundary layer flows, relation between thermal and hydrodynamic boundary layer theories, Reynolds analogy and Colburn analogy, non dimensional numbers governing boundary layer flows, numericals	8
4.	TRANSITION: Pipe flow and flow over a flat plate, critical Reynolds number, turbulent	6

	spots, principles of theory of stability of Laminar flows, Summerfield equation, factors effecting transition, Laminar aero foils.	
5.	BOUNDARY LAYER CONTROL: Need of boundary layer control, causes of boundary layer separation, flow over the cylinder and aerofoil for different flow conditions leads separation, Method of boundary layer control	6
6.	UNSTEADY VISCOUS FLOW: Startup of plane Couette flow, unsteady flow over a cylinder	4
7.	TURBULENT BOUNDARY LAYERS: Fundamentals of turbulent flow, Mean motion fluctuations, Reynolds Equations, Reynolds stresses, wind tunnel turbulence, Prandtl's mixing length theory, Von kamran's similarity hypothesis, velocity distribution laws, numericals	6
8.	TURBULENT FLOW THROUGH PIPE: Flow thorough pipe, governing equations and velocity profile for fully developed flow through pipe, effect of roughness, smooth pipes, relation between laws of friction & velocity distribution, universal resistance law for smooth pipe at large Reynold number, rough pipe and equivalent roughness, numericals	8

Text Books:

1. Fluid mechanics by Bansal
2. Heat transfer R.K.Rajput

Reference Books:

1. Introduction to fluid mechanics by deward shaughnessy
2. Boundary layer theory by h. Schlichting
3. Further aerodynamics for engg. Students by houghton and boswell