

EXPERIMENTAL AERODYNAMICS

VI Semester: AE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AAEB35	Elective	L	T	P	C	CIA	SEE	Total
		3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes:Nil	Practical Classes: Nil			Total Classes: 45			
COURSE OBJECTIVES: The students will try to learn:								
I	The constructions of low speed tunnel, high speed tunnels, transonic, supersonic and hypersonic tunnels and geometric similarity, kinematic similarity and dynamic similarity experiment techniques used for analysis aerodynamic problems							
II	The description, design constraints and loss coefficients, and estimation and correction of blockages in wind tunnels for receiving precise values while conducting experiments							
III	The principles and applications of Load measurement, Pressure, Velocity, Temperature and flow visualization techniques used in wind tunnel for validating the results experimentally.							
COURSE OUTCOMES: After successful completion of the course, students will be able to:								
CO 1	Explain the need of wind tunnels and their measuring techniques for analysis of model using geometric similarity, kinematic similarity and dynamic similarity.							
CO 2	Classify the types of wind tunnels based on wind speeds for designing the prototypes and their applications aerospace industries.							
CO 3	Identify the principal components of low speed wind tunnel and their functions for determining loss coefficients and constraints.							
CO 4	Illustrate the methods for the improvements of wind tunnel performance and corrective measures for obtaining accurate results with wind tunnel experiments.							
CO 5	Demonstrate low speed wind tunnel balances, mechanical and Strain gauge types, null displacement methods and strain method and etc for load measurement using wind tunnel balance.							
CO 6	Explain the model supports used in wind tunnel for load measurement.							
CO 7	Identify the principles of probes and transducers used in pressure, velocity & temperature measurements techniques.							
CO 8	Demonstrate methods used for equipments settings, calibration, measurement data, and processing of gauges used in of pressure, velocity and temperature measurements.							
CO 9	Identify the necessity of streamlines, streak lines, path lines, time lines, tufts, china clay, oil film, smoke and hydrogen bubble for flow visualization of wind in wind tunnel.							
CO 10	Demonstrate the relative merits and demerits of flow visualization techniques followed with their applications for flow visualization in wind tunnel.							
CO 11	Identify the applications of wind tunnels for the analysis of load, pressure, velocity and temperature measurements using flow visualization for the analysis of aerodynamic problems in automobile and aerospace industries.							

MODULE-I	FUNDAMENTALS OF EXPERIMENTS IN AERODYNAMICS	Classes: 08
Forms of aerodynamic experiments, observations, measurement objectives. History: Wright Brother's wind tunnel, model testing, wind tunnel principles, scaling laws, scale parameters, geometric similarity, kinematic similarity & dynamic similarity. Wind tunnels: low speed tunnel, high speed tunnels, transonic, supersonic and hypersonic tunnels, shock tubes. Special tunnels: low turbulence tunnels, high Reynolds number tunnels, environmental tunnels, automobile tunnels, distinctive features, application.		
MODULE -II	WIND TUNNEL EXPERIMENTATION CONSIDERATIONS	Classes: 08
Low speed wind tunnels, principal components. Function, description, design requirements, constraints and loss coefficients. Wind tunnel performance flow quality, power losses, wind tunnel corrections, sources of inaccuracies: buoyancy, solid blockage, wake blockage, streamline curvature causes, estimation and correction.		
MODULE -III	WIND TUNNEL BALANCE	Classes: 09
Load measurement: low speed wind tunnel balances, mechanical & Strain gauge types, null displacement methods & strain method, sensitivity, weigh beams, steel yard type and current balance type, balance linkages, levers and pivots. Model support three point wire support, three point strut support, platform balance, yoke balance, strain gauge, 3- component strain gauge balance, description, application.		
MODULE -IV	PRESSURE, VELOCITY & TEMPERATURE MEASUREMENTS	Classes: 10
Pressure: static pressure, surface pressure orifice, static probes, pitot probe for total pressure, static pressure and flow angularity, pressure sensitive paints, steady and unsteady pressure measurement and various types of pressure probes and transducers, errors in pressure measurement. Temperature: measurement of temperature using thermocouples, resistance thermometers, temperature sensitive paints and liquid crystals. Velocity: measurement of airspeed, Mach number from pressure measurements, flow direction, boundary layer profile using pitot static probe, 5 hole probe yaw meter, total head rake, hot wire anemometry, laser doppler anemometry, particle image velocimetry, working principle description of equipment, settings, calibration, measurement, data processing, applications.		
MODULE -V	FLOW VISUALIZATION TECHNIQUES	Classes: 10
Flow visualization: necessity, streamlines, streak lines, path lines, time lines, tufts, china clay, oil film, smoke, hydrogen bubble. Optical methods: density and refractive index, schlieren system, convex lenses, concave mirrors, shadowgraph, interferometry, working principle, description, setting up, operation, observation, recording, interpretation of imagery, relative merits and applications.		
Text Books:		
1. Jewel B Barlow, William H Rae Jr. & Alan Pope, —Low Speed Wind Tunnel Testing, John Wiley & Sons Inc, Re-Print, 1999. 2. Alan Pope, Kenneth L Goin, —High Speed Wind Tunnel Testing, John Wiley & Sons, Reprint, 1965.		
Reference Books:		
1. Gorlin S M & Sleuzinger I I, —Wind tunnels & Their Instrumentations, NASA publications, Translated version, 1966. 2. Jorge C Lerner & Ulfilas Boldes, —Wind Tunnels and Experimental Fluid Dynamics Research, In Tech, 1st Edition, 2011. 3. Liepmann H W and Roshko A, —Elements of Gas Dynamics, John Wiley & Sons, 4th Edition, 2003.		

Web References:

1. <https://nptel.ac.in/courses/101106040/>
2. <https://ocw.metu.edu.tr/course/view.php?id=66>
3. <https://www.mace.manchester.ac.uk/our-research/research-themes/aerospaceengineering/specialisms/>
4. <https://www.ara.co.uk/services/experimental>
5. <https://soliton.ae.gatech.edu/labs/windtunl/>

E-Text Books:

1. <https://www.scribd.com/doc/221788571/Wind-Tunnel-Testing-Barlow-Rae-Pope>
2. <https://www.scribd.com/document/84868596/Wind-Tunnelsibooksonline.com/library/view/data-structures-using/9789332524248/>