



# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

## COURSE CONTENT

TECHNIQUES IN WIND TUNNEL TESTING								
VII Semester: AE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AAEC36	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	
Prerequisite: Aerodynamics								
<b>I. COURSE OVERVIEW:</b>								
<p>The experimental aerodynamics is the first course for graduate and undergraduate students in Aerospace Engineering. The testing methodology employed in low and high-speed aerodynamics is a new techniques through which the students will learn various types of wind tunnels, tools and techniques. The experimental aerodynamics will be helpful to industrial aerodynamics study in various engineering branches like, environmental engineering, civil engineering, Automobile engineering etc., so that students get exposure to the various aspects of the subject related issues to measuring techniques, wind tunnel design, method and practical applications used. This subject will help the students to develop the tool by using multidisciplinary techniques. A number of problems/examples will be cited to enhance the understanding of the subject matter and besides, many unsolved problems will be provided with answers to further test the student's learning.</p>								
<b>II. COURSE OBJECTIVES:</b>								
<b>The student will try to learn:</b>								
<p>I. The basic fundamentals of Aerodynamics experiments, their need in comparison with numerical computation and theoretical studies.</p> <p>II. The concepts of flow similarity and evaluate the loss coefficients of wind tunnel components.</p> <p>III. The concept of force and moment measurements using wind tunnel balance and extrapolate it to new balance development.</p> <p>IV. The various techniques for pressure, velocity, temperature measurement and flow visualization.</p>								
<b>III. COURSE SYLLABUS:</b>								
<b>MODULE-I: FUNDAMENTALS OF EXPERIMENTS IN AERODYNAMICS (10)</b>								
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.								
<b>MODULE –II: WIND TUNNEL EXPERIMENTATION CONSIDERATIONS (08)</b>								
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.								
<b>MODULE –III: WIND TUNNEL BALANCE (10)</b>								
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, 3component strain gauge balance, description, application.								

**MODULE –IV: PRESSURE, VELOCITY & TEMPERATURE MEASUREMENTS (09)**

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 (08)**

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

**IV. TEXT BOOKS:**

1. Jewel B Barlow, William H Rae Jr. & Alan Pope, “Low Speed Wind Tunnel Testing”, John Wiley & Sons, Reprint, 1999.
2. Alan Pope, Kenneth L Goin, “High Speed Wind Tunnel Testing”, John Wiley & Sons, Reprint, 1965.

**V. REFERENCE BOOKS:**

1. Gorlin S M & Slezinger I I, “Wind tunnels & Their Instrumentations”, NASA publications, Translated version, 1966.
2. Jorge C Lerner & Ulfilas Boldes, “Wind Tunnels and Experimental Fluid Dynamics Research”, InTech, 1<sup>st</sup> Edition, 2011.
3. Liepmann H W and Roshko A, “Elements of Gas Dynamics”, John Wiley & Sons, 4<sup>th</sup> Edition, 2003.