INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

TECHNIQUES IN WIND TUNNEL TESTING									
VI Semester: AE									
Course Code	Category	Hours / Week			Credits	Maximum Marks			
AAED29	Elective	L	T	P	C	CIA	SEE	Total	
		3	0	-	3	40	60	100	
Contact Classes: 48	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 48			
Prerequisite: Fluid Dynamics, Aerodynamics and Gas Dynamics									

I. COURSE OVERVIEW:

Techniques in Wind Tunnel Testing deals with development of tools employed in low-speed aerodynamics and high-speed aerodynamics for measuring parameters such as Pressure, Velocity and Temperature Measurements. It is multi-disciplinary subject and useful in environmental engineering, civil engineering, Automobile engineering in designing vehicle and construction and building and bridges by using low speed wind tunnel balance. 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. 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. This subject will help the students to develop the tool by using multidisciplinary techniques.

II. COURSES OBJECTIVES:

The students will try to learn:

I. Understanding wind tunnel principles
II. Learn the practical aspects of setting up and conducting wind tunnel experiments
III. Gain hands-on experience with data acquisition systems and sensors used in wind tunnel testing.
IV. Develop skills in evaluating the aerodynamic performance of various objects, such as airfoils, wings, and complete aircraft models, through wind tunnel testing.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO1 Memorize the characteristics of different types of wind tunnels and their respective applications.
CO2 Demonstrate an understanding of the relationships between aerodynamic parameters and the design and operation of wind tunnels.
CO3 Apply experimental techniques to set up and conduct wind tunnel experiments, including the proper selection and placement of instrumentation for data collection.
CO4 Analyze and interpret aerodynamic data obtained from wind tunnel experiments, including lift, drag, and moment measurements.
CO5 Evaluate the accuracy and reliability of experimental data and propose improvements or alternative methodologies.
CO6 Design and plan a wind tunnel experiment, considering the objectives, parameters, and instrumentation required for a specific aerodynamic analysis.

IV. COURSE CONTENT:

MODULE–I: FUNDAMENTALS OF EXPERIMENTS IN AERODYNAMICS (09)

Necessity of Wind Tunnels; Basic Principle; Types of Wind Tunnels; Components of Subsonic Tunnel, Supersonic Tunnel, Hypersonic windtunnels, Hypervelocity Facilities; Special Purpose Wind Tunnel, Aeroacoustic Wind Tunnels; Design Consideration of Subsonic Tunnel and Supersonic Tunnel;

MODULE–II: CALIBRATION METHODS AND WIND TUNNEL BALANCE ((10)

Calibration Methods of different Wind Tunnels. Wind Tunnel Balance: Wire Balance, Strut-type balance, Yoke Balance, Platform type balance and Strain Guage Balance. Power Losses in a Wind Tunnel, Null displacement methods & strain method, Balance linkages, levers and pivots

MODULE–III: PRESSURE, VELOCITY & TEMPERATURE MEASUREMETNS (11)

Measurement of temperature using thermocouples, resistance thermometers, temperature sensitive paints and liquid crystals. Steady and unsteady pressure measurements and various types of pressure probes and transducers, Linear Variable Differential Transformer, errors in pressure measurements.

Temperature measurements: thermocouples, thermography, velocity measurement using hot wire anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry. Experiment on Taylor-Proudman Theorem.

MODULE–IV: FLOW VISUALIZATION TECHNIQUES (09)

Flow visualization: necessity, streamlines, streak lines, path lines, time lines, tufts, China clay, oil film, smoke, hydrogen bubble. Hele-Shaw apparatus, schlieren system, Fringe-Displacement method, shadowgraph, interferometry: working principle, description, setting up, operation, observation, recording, interpretation of imagery, relative merits and applications

M**ODULE – V Data Acquisition (09)**

Data Acquisition Principle, Data acquisition and digital signal processing techniques, Multiplexing wind tunnel data acquisition, measurement of steady and unsteady pressure, velocity, temperature, turbulence intensity, calibration of force, pressure and acoustic sensors. Virtual instrumentation, Calibration of single and two wire probes.

V. 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, Kennith L Goin, “High Speed Wind Tunnel Testing”, John Wiley & Sons, 1965.

VI. REFERENCE BOOKS:

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

VII. ELECTRONICS RESOURCES:

1. https://nptel.ac.in/courses/101/106/101106082/
2. https://nptel.ac.in/courses/101/104/101104078/
3. https://www.grc.nasa.gov/www/k-12/airplane/shortp.html

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation