

COURSE CODE	COURSE TITLE	L	T	P	C
1152AE117	Experimental Aerodynamics	3	0	0	3

Course Category:

Programme Elective

a. Preamble :

The course is designed as a core course for the undergraduate students of Aeronautical engineering and To introduce the basic concepts of non-dimensional numbers, problems associated with wind tunnel testing at different speed regimes, velocity, pressure and force measuring equipment's and also flow visualization techniques.

b. Prerequisite Courses:

- Compressible flow Aerodynamics

c. Related Courses:

- Computational Fluid Dynamics

d. Course Educational Objectives :

Students undergoing this course are expected to

- Understand the need of wind tunnel and its basic principles.
- Know about the layouts of wind tunnels at different speed regimes.
- Know about the basic important design parameters for various tunnel layouts.
- Gain knowledge on quantitative measurement techniques and problems associated with wind tunnel testing at different speed regimes
- Emphasis knowledge on qualitative measurement techniques in wind tunnels.

e. 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	Develop the dimensional analysis to design an experiment.	K5
CO2	Describe the various layouts of wind tunnels	K4
CO3	Identify the basic design parameters of different layouts of wind tunnels	K6
CO4	Summarize the various Quantitative measurement techniques used in wind tunnel testing.	K5
CO5	Summarize the various Qualitative measurement techniques used in wind tunnel testing.	K5

f. Correlation of COs with POs :

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

g. Course Content :

UNIT- I Basics of wind tunnel testing 9

Need And Objective Of Experimental Study, Review of non-dimensional numbers, similarity rule- types of similarity, scale effect and boundary layer effect, Dimensional analysis, Numerical problems, Basics of Design of experiment.

UNIT- II Wind tunnel layouts 9

Wind Tunnel layouts, subsonic wind tunnel- based on construction, based on power, supersonic wind tunnel layout- intermittent blowdown, in-draft tunnel, hypersonic tunnels-conventional hypersonic tunnel, impulse tunnel, shock tunnels, hot shot tunnel, expansion tubes High enthalpy tunnels, Special Purpose Wind Tunnel.

UNIT III Basic Design parameters of wind tunnels 9

Design parameters of subsonic wind tunnel- Power requirement, calculation of power losses, test section speed calibration for incompressible and compressible subsonic flow, Design parameters of high speed tunnels- dynamic pressure, mass flow rate, test section speed, maximum velocity, free stream Re number, starting and unstarting of tunnel, special problems in subsonic wind tunnel- surging, horizontal buoyancy, secondary flow problems, blockage effect, special problems in supersonic wind tunnel-flow freezing, condensation, liquefaction, Real gas effects in high speed tunnels

UNIT –IV Quantitative measurement techniques 9

Pressure measuring instruments- Review of Fluid Mechanics pressure Measurements- manometers, Barometers, Bourdon gauges , elastic diaphragms, electrical Pressure Transducers, Piezoelectric transducers, Pressure sensitive paints, Velocity measurements-Intrusive measurements- Pitot and pitot static probes, Thermal anemometers etc., Non-intrusive measurements- Laser Doppler anemometer, Particle image velocimetry, Force Measurements – Internal and external strain gauges, 3 and 6 component force balance systems, Flow angularity measurements- Yaw meters, Longitudinal pressure gradient measurements Pitot rake.

UNIT- V Qualitative measurement techniques

9

Need And Objective Of flow visualizations, Broad classifications of flow visualizations, incompressible flow visualization techniques, compressible flow visualization techniques, Optical flow visualization techniques.

TOTAL: 45 periods

Text Books :

1. Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids "
2. Rae, W.H. and Pope, A. "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.
3. Rae, W.H. and Pope, A. "High Speed Wind Tunnel Testing", John Wiley Publication, 1984.

Reference:

1. Wind Tunnel Techniques - Pankrust, R.C and Holder,D.W.
2. Shock Tubes in high temperature chemical physics Gaydon, A.G. and Hurlle, J.R
3. Wind Tunnels and their Instrumentation – Slezinger
4. Measurement Systems: Application & Design – Doebelin
5. Fluid Mechanics measurements - edited by Goldstein

Online resources

<http://nptel.ac.in>