SEMESTER 6

EXPERIMENTAL AERODYNAMICS

Course Code	PEAOT636	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Aerodynamics, High speed Aerodynamics	Course Type	Theory

Course objectives:

1. Estimate energy ratios and power requirements in low-speed wind tunnels evaluation of Aerodynamic Forces.
2. Measure and estimation of Flow Characteristics
3. Analyze boundary layer effects, determine velocity profiles, calculate drag coefficients
4. Understand and apply various flow visualization techniques

SYLLABUS

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Module No.	Syllabus Description	Contact Hours
1	**Subsonic and supersonic wind tunnel**: - Low speed wind tunnels - Estimation of energy ratio and power required supersonic wind tunnels - Calculation of running time and storage tank requirements– Shock tunnel. Pressure and velocity distributions: - Calculation of CL and CD on aerofoils from pressure distribution - CD from wake survey - Span wise load distribution for different taper ratios of wing.	9
2	**Pressure, velocity and temperature measurements**: - Mach number estimation in test section by pressure measurement and using a wedge - Hot wire anemometer and laser Doppler anemometer for turbulence and velocity measurements - Use of thermocouples and pyrometers for measurement of static and total temperatures - Use of pressure transducers, Rotameters, and ultrasonic flow meters.	9
3	**Boundary layer effects and heating problems**: - Pitot-static tube correction for subsonic and supersonic Mach numbers - Boundary layer effects -Velocity profile on a flat plate by momentum integral method - Calculation of CD from wall shear stress - Heating requirements in hypersonic wind tunnels - Re-entry problems	9

4	**Flow Visualization and its advancements** Principles of Flow Visualization – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph. Theories of -Digital particle image velocimetry (DPIV), Tomographic particle image velocimetry (TOMO-PIV), advanced computational flow visualization, 3d flow visualization using holography, volumetric velocimetry, flow visualization in multiphase flows	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

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In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the behaviour of subsonic and supersonic wind tunnels. Understand the lift and drag coefficient calculation for pressure and velocity distributions	**K2**
CO2	Understand the various velocity, pressure, and temperature measurement techniques.	**K2**
CO3	Understand the boundary layer effects and heating problems	**K2**
CO4	Understand the various flow visualization techniques and its advancement.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

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Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	High speed wind tunnel testing	Pope. A and Goin. L	John Wiley	1985
2	Low speed wind tunnel testing"	Rae W.H and Pope. A	John Wiley Publication	1984
3	Instrumentation, Measurement and Experiments in Fluids	Rathakrishnan. E	CRC Press, London,	2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Experimental Fluid Mechanics	Bradsaw	Oxford	1977
2	Supersonic Aerodynamics	Edward R. C. Miles	Dover, New York	1957
3	Lecture course on Advanced Flow Diagnostic Techniques 17	NAL, Bangalore.		19 September 2008

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Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/101/105/101105088/
2	https://archive.nptel.ac.in/courses/101/105/101105088/
3	https://archive.nptel.ac.in/courses/101/105/101105088/
4	https://archive.nptel.ac.in/courses/101/105/101105088/

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