

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO409	WIND TUNNEL TECHNIQUES	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives			
<ul style="list-style-type: none"> To introduce various types and techniques of Aerodynamic data generation on aerospace vehicle configurations in the aerospace industry. 			
Syllabus			
Principle of model testing-similitude - wind tunnel testing in subsonic, transonic, supersonic and hypersonic speed regions - Layouts - Test section speed - Horizontal buoyancy – Flow angularities – Flow uniformity & turbulence measurements - Associated Instrumentation - Calibration – Force, Pressure and Velocity measurements - Intake tests – wind tunnel model design - performance study on shock tube tunnel - Flow visualization techniques			
Expected Outcome			
<ul style="list-style-type: none"> The students will be able to use various techniques of aerodynamic data generation. 			
Text Books:			
<ol style="list-style-type: none"> NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998 Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984. 			
References:			
<ol style="list-style-type: none"> Bradsaw, "Experimental Fluid Mechanics", Pergamon, Oxford, 1970 Lecture course on Advanced Flow diagnostic techniques, 17-19 September 2008 NAL, Bangalore Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Principle of model testing-Buckingham Theorem	1	15%
	Non-dimensional numbers	2	
	Scale effect, models, prototype	2	
	Geometric Kinematic and Dynamic similarities	2	
II	Classification and types of wind tunnel	2	15%
	special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions	3	
	Layouts – sizing and design parameters. Tunnel blockage factor	2	
FIRST INTERNAL EXAM			
III	Test section speed	2	15%
	Horizontal buoyancy – Flow angularities – Flow uniformity & turbulence measurements	3	
	Associated instrumentation, yaw meter, yaw sphere, turbulence	3	

	sphere		
	Calibration of subsonic & supersonic tunnels	2	
IV	Force measurements and measuring systems	2	15%
	Multi component internal and external balances	2	
	Pressure measurement system - Steady and Unsteady Pressure-single and multiple measurements	2	
	Velocity measurements – Intrusive and Non-intrusive methods	2	
SECOND INTERNAL EXAM			
V	Intake tests – store carriage and separation tests	2	20%
	Unsteady force and pressure measurements	1	
	wind tunnel model design	1	
	performance study on shock tube tunnel	2	
VI	Flow visualization techniques- surface flow, oil and tuft	2	20%
	flow field visualization, smoke and other optical and nonintrusive techniques	2	
	Schlieren effect-Dye injection techniques	1	
	Particle Image Visualization	1	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.