



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3170209

Semester – VII

Subject Name: Automotive Aerodynamics and Aesthetics

Type of course: Professional Core/Elective

Prerequisite: Fluid Mechanics

Rationale: At the end of the course, the students will be able to apply basic principles of aerodynamics for the design of vehicle body and importance of aesthetics.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
1	Introduction: - Introduction of air flow, boundary layer velocity profile, mechanics of air flow and pressure around a vehicle, flow separation, vehicle aerodynamic performance, characteristics of aerodynamic forces and moments, drag of a simple bodies plate, sphere and streamline bodies, SAE aerodynamic axis system	08
2	Aerodynamic lift and drag: - Aerodynamic Drag: Pressure (form) drag, air resistance opposing the motion of a vehicle, after flow wake, drag coefficient, drag coefficient and various body shapes, base drag, vortices, trailing vortex drag, attached transverse vortices. lift coefficients, vehicle lift, underbody floor height versus aerodynamic lift and drag, aerofoil lift and drag.	07
3	Aerodynamic drag reduction and lift control: - Profile edge rounding or chamfering, bonnet slop and windscreen rake, roof and side panel cambering, rear side panel taper, underbody rear end upward taper, rear end tail extension, underbody roughness. Aerodynamic lift control: under body dams, exposed wheel air pattern, partial enclosed wheel air flow pattern, rear end spoiler, negative lift air foil wings.	06
4	Shape optimization of cars: - Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, notchback drag, kamm-back, cabriolet cars. dust flow patterns at the rear, effects of gap configuration, effect of fasteners.	04
5	Commercial vehicle aerodynamics fundamental: - Principles of Commercial Vehicle Aerodynamics, effect of rounding sharp front cab body edges, effect of different cab to trailer body heights with both sharp and rounded upper windscreen leading edges, forebody pressure distribution, effect of a cab to trailer body roof height step. Commercial vehicle drag reducing devices: - cab roof deflectors, yaw angle, cab roof deflector effectiveness versus yaw angle, comparison of drag resistance with various commercial vehicle cab arrangement relative to trailer body height, corner vanes, cab to trailer	06



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	body gap, cab to trailer body gap seals, tractor and trailer skirting, comparison of various devices used to reduce vehicle drag, effect of trailer load position on a vehicle's drag resistance.	
6	Aerodynamic testing: - Wind tunnel testing and measurement: Function, features and types of wind tunnels, types of wind tunnel test sections, divergent and convergent collector in wind tunnel, test sequence, measurement of flow velocity, measurement of flow direction, pressure measurements, measurements of aerodynamic loads using wind tunnel balances, measurement of the frontal area, flow visualization scale model testing, full scale testing in wind tunnel On-road testing and measurements: drag measurement using Coastdown tests, crosswind tests, on-road cooling tests, soiling of windows and chassis parts, on-road measurements of the wind noise	07
7	Automobile aesthetics: - Definition, aerodynamic vehicle development process and importance of the aesthetic aspects, technical criteria for aesthetic design of exterior and interior, digital aesthetic design process, Body styling process: Product planning, package, concept sketching and package related sketching, full sized tape drawing, clay modelling	07

Suggested Specification table with Marks (Theory):

Distribution of Theory % Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	20	30	20	0	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Product Design and Development by AK Chitale and Gupta
2. Automotive Aerodynamic: Update SP-706 - SAE - 1987
3. Vehicle Aerodynamics - SP-1145 - SAE - 1996.
4. Hucho.W.H. - "Aerodynamic of Road Vehicles" - Butterworth's Co., Ltd., - 1997
5. Pope, A, Wind Tunnel Testing, John Wiley & Sons, 2nd Edn., New York, 1994.
6. Low Speed Wind Tunnel Testing by J. B. Barlow, W. H. Rae, Jr, A. Pope.
7. Advanced Vehicle Technology by Heinz Heisler.
8. Race Car Vehicle Dynamics by Milliken and Milliken.
9. Aerodynamics of Road Vehicles by Thomas Christian Schuetz.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Illustrate various flow phenomenon related to vehicles	20
CO-2		20



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	Demonstrate and analyse different types of drag forces and provide exposure on drag/lift reduction enhancing vehicle performance	
CO-3	Optimize various shape configurations in automobiles	10
CO-4	Illustrate the principle of wind tunnel technology	30
CO-5	Develop an ability to interpret aesthetic design and its significance for vehicle aerodynamic performance.	20

List of Open Source Software/learning website:

1. <http://nptel.ac.in/>
2. <http://npti.in/default.aspx>

Industrial Visit: It is strongly suggested and recommended to arrange a visit to automotive workshop/garages and auto industries

List of Experiments:

1. Study terminologies related to vehicle aerodynamics and SAE vehicle aerodynamic axis.
2. Measure and study effect of vehicle aerodynamic on fuel economy and power consumption.
3. Prepare /study any vehicle scale model for wind tunnel testing using standard procedure.
4. Perform and study wind tunnel testing for simple bodies like plate, sphere, aerofoil to measure drag and lift.
5. Perform and study wind tunnel testing for pressure distribution and flow pattern around any small scale vehicle (car/bus) model.
6. Study the effect of different aerodynamic aids for reduction of vehicle drag and control of lift.
7. Study/Measure the drag reduction aids for any commercial vehicle/vehicle model.
8. Study drag measurement using road testing e.g. Coast down tests, crosswind tests, on-road cooling tests, soiling of windows and chassis parts, wind noise etc.
9. Identify various technical criteria for aesthetic exterior and interior design.
10. Study body styling process and digital aesthetic design process.