



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

GROUND VEHICLE AERODYNAMICS

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P		CIA	SEE	Total
BAEE17	Elective	3	-	-	3	40	60	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

Prerequisite: Aerodynamics

I. COURSE OVERVIEW:

This subject deals with automotive Aerodynamics are the study of air flows around and through the vehicle body. More generally, it can be labelled “Fluid Dynamics” because air is really just a very thin type of fluid. Above slow speeds, the air flow around and through a vehicle begins to have a more pronounced effect on the acceleration, top speed, fuel efficiency and handling. Influence of flow characteristics and improvement of flow past vehicle bodies to reduction of fuel consumption, more favorable comfort characteristics (mud deposition on body, noise, ventilating and cooling of passenger compartment) and improvement of driving characteristics (stability, handling, traffic safety)

II. COURSE OBJECTIVES:

The students will try to learn:

- I. The basics of vehicle aerodynamics, history of developments and apply the concepts of fluid mechanics to automobiles.
- II. The drag on ground vehicles and analyze the effects of various configurations of cars on drag.
- III. The stability and handling qualities based of ground vehicles due to side wind loads and dirt accumulation.
- IV. The concepts to race car design and understand various experimental techniques applied in automotive aerodynamics.

III. COURSE OUTCOMES:

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

- CO 1 Apply the knowledge of fluid mechanics, and aerodynamics for designing a frontal portion of a vehicle.
- CO 2 Analyze the lateral stability problems of vehicle to improve the vehicle dynamics under different conditions.
- CO 3 Apply the knowledge of mechanisms, and measurement techniques for the stability of ground vehicle
- CO 4 Apply the knowledge of flow behavior over different components of race vehicle for designing a race car
- CO 5 Apply the knowledge of wind tunnel test for optimizing the ground vehicle design.
- CO 6 Apply the knowledge of measuring equipment and transducers to investigate the roadside performance of vehicle.

IV. COURSE CONTENT:

MODULE-I: OVERVIEW AND INTRODUCTION (09)

Historical developments and trends, fundamentals of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problem, resistance to vehicle motion, mechanics of air flow around a vehicle, pressure distribution, aerodynamic forces, vehicle drag and types, side and lift forces, performance potential of vehicle aerodynamics.

MODULE-II: AERODYNAMIC DRAG AND SHAPE OPTIMIZATION OF CARS (09)

Cars as a bluff body, flow field around a car, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles. Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effect of rear configuration, effect of fasteners.

MODULE-III: VEHICLE HANDLING AND STABILITY (09)

Origin, characteristics and effects of forces and moments on a vehicle, lateral stability problems. Vehicle dynamics under sidewinds, dirt accumulation on the vehicle.

Wind noise: Mechanisms and generation design features, measurement and techniques.

MODULE-IV: RACE CAR AERODYNAMICS (09)

Basic vehicle body concepts, aerodynamics of the complete vehicle, flow over wheels, sliding seal and skirts, under body channels, simply add on: spoilers, strakes and wickers, internal flow, race car wings, most current examples in detail design.

MODULE-V: MEASUREMENT AND TEST TECHNIQUES (09)

Wind tunnel scope, fundamental techniques, simulation limitations, prototype tests, wind tunnel types and testing methods, test techniques: scope, measuring equipment and transducers, road testing methods.

V. TEXT BOOKS:

1. Wolf-Heinrich Hucho, "Aerodynamics of Road Vehicles", SAE International, 1998.
2. Joseph Katz, "Race Car Aerodynamics Designing for Speed", Bentley Publishers, 2nd edition, 1996.

VI. REFERENCE BOOKS:

1. Alan Pope, "Wind Tunnel Testing", John Wiley & Sons, 2nd edition, 1974.

VII. ELECTRONICS RESOURCES:

1. <https://www.buildyourownracecar.com/race-car-aerodynamics-basics-and-design/>
2. <https://www.ara.bme.hu/oktatas/letolt/Vehicleaerodyn/Vehicle aerodyn.pdf>
3. <https://auto.howstuffworks.com/fuel-efficiency/fuel-economy/aerodynamics.html>
<https://www.slideshare.net/friendsrsg/vehicle-body-engineering-aerodynamics>

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.