## SEMESTER S7

# VEHICLE AERODYNAMICS

| | | | |
|---|---|---|---|
| **Course Code** | **PEAUT752** | **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)** | NA | **Course Type** | Theory |

**Course Objectives:**

1. The course will impart knowledge of aerodynamic fundamentals and their effects on vehicle performance.
2. To introduce aerodynamic testing using wind tunnel testing, CFD, with the relative merits and limitations.
3. To enhance aerodynamic design for various vehicles.

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## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction to Aerodynamics**-Concept of Fluids, **Basic Fluid Mechanics**-Fluid properties related to aerodynamics, Forces in a fluid, Compressibility and incompressibility, Reynolds Number (Re), Mach number, Laminar and turbulent flow, hypersonic flows, Boundary Layer, Flow separation, Streamlines Streak lines and Path lines, Flow Visualization Techniques-types and application | **9** |
| 2 | **Fundamentals of Aerodynamics-** Resistances to vehicle motion. Aerodynamic drag, Effects of air resistance in vehicle performance and stability, pressure drag, Air flow wake, Relation between air resistance, frontal area, and vehicle velocity, drag co-efficient (simple problems related to the relations), Idea of drag co-efficient of various shapes. | **9** |
| 3 | **Aerodynamic lift and** Downforce -Vehicle Handling-The origin of force and moments on a vehicle, Effects of forces and moments, Side wind problems, Vehicle dynamics Under side winds, Car body drag reduction, wind noise, Aerodynamic lift control- Aerodynamic aids, after body drag- square back | **9** |

| | | |
|---|---|---|
| | drag, fast back drag, notch back drag, hatch back drag. Effect of down force on vehicle performance, Vortices | |
| **4** | **Aerodynamic Testing**- Wind Tunnels for Automotive, Principles of wind tunnel technology, Types, and components of wind tunnel. Limitation of simulation – Stress with scale models – Full scale wind tunnels – Measurement techniques – Equipment and transducers – Road testing methods, numerical methods-CFD. Aerodynamic study of F1 Racing cars, Sports car, SUVs. | **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** |

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**End Semester Examination Marks (ESE)**

*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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(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 fluid mechanics, Reynolds number, boundary layers, and flow visualization | **K2** |
| **CO2** | Analyze aerodynamic drag, air resistance, drag coefficient, and their effects on vehicle performance | **K3** |
| **CO3** | Understand aerodynamic lift, downforce, side winds, drag types, and their impact on vehicle performance. | **K2** |
| **CO4** | Comprehensive understanding aerodynamic testing techniques, wind tunnels, CFD, and road-testing methods | **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 | 1 | | 1 | | | | | | | | 1 |
| **CO2** | 3 | 3 | | 1 | | | | | | | | 1 |
| **CO3** | 3 | 1 | 2 | | | | 1 | | | | | 1 |
| **CO4** | 3 | 1 | | 2 | 3 | | | | 2 | 2 | | 2 |

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 | Aerodynamics for Engineers | John J Bertin | PEARSON | 4rth ,2013 |
| 2 | Automotive Aerodynamics | Joseph Katz | WILEY | 2016 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Aerodynamics of Road Vehicles | Thomas Christian Schuetz | SAE International | 5th, 2015 |
| 2 | Aerodynamics of Road Vehicles | Wolf-Heinrich Hucho | SAE International | 1998 |
| 3 | Aerodynamics for Engineering Students | E.L. Houghton, P.W. Carpenter, Steven H. Collicott, Daniel T. Valentine | BH | 5th, 2013 |