

MANIPAL INSTITUTE OF TECHNOLOGY

A Constituent Institution of Manipal University

VI SEMESTER B.TECH. (AUTOMOBILE ENGINEERING) MAKEUP EXAMINATIONS, JUNE 2017

SUBJECT: VEHICLE AERODYNAMICS [AAE 3251]

REVISED CREDIT SYSTEM (15/06/2017)

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ALL the questions.
- Missing data may be suitable assumed.
- 1A. With suitable sketch explain the laminar, turbulent and transition boundary (03) layer and also mention their significance on vehicle aerodynamics.
- **1B.** With neat sketch explain the forces and moments acting on a vehicle. **(03)**
- 1C. Classify the aerodynamic drag as per origin locations. Plot and explain (04) pressure distribution in longitudinal cross section for a sharp and rounded front end structure.
- 2A. Sketch and explain the effect of lowering the roof end and effect of roof (04) camber on aerodynamic drag of a passenger car.
- 2B. With suitable sketch explain the flow pattern and pressure distribution on the (04) rear side of a notchback.
- 2C. A car is moving at a constant velocity of 110 km/h. Determine the upstream (02) velocity to be used in fluid flow analysis if (a) the air is calm, (b) wind is blowing against the direction of motion of the car at 30 km/h, and (c) wind is blowing in the same direction of motion of the car at 30 km/h.
- 3A. With neat sketch explain the process involved in shape optimization process. (03)
- **3B.** During major windstorms, high vehicles such as RVs and semis may be **(03)** thrown off the road and boxcars off their tracks, especially when they are empty and in open areas. Consider a 5000-kg semi that is 9 m long, 2.5 m high, and 2 m wide. The distance between the bottom of the truck and the road is 0.75 m. Now the truck is exposed to winds from its side surface.

Determine the wind velocity that will tip the truck over to its side. Take the air density to be 1.1 kg/m³ and assume the weight to be uniformly distributed. Take drag coefficient as 2.2.

- **3C.** What are the functions of rear spoiler? With suitable sketch explain effect of **(04)** spoiler height on lift at front and rear axle, and effect on drag
- **4A.** With suitable sketch explain the effects of rounding sharp front cab body **(03)** edges.
- **4B.** Sketch and explain the effects of articulated and rigid cab deflectors on **(04)** aerodynamics of commercial vehicle.
- 4C. What do you mean by corner vanes? Explain how it is useful in reducing the (03) drag of the vehicle.
- **5A.** Circular sign has a diameter of 50 cm and is subjected to normal winds up to (02) 150 km/h at 10°C and 100 kPa. Determine the drag force acting on the sign. Also determine the bending moment at the bottom of its pole whose height from the ground to the bottom of the sign is 1.5 m. Disregard the drag on the pole. The drag coefficient for a thin circular disk is $C_D = 1.1$.



- **5B.** With neat sketch explain the working principle of projection manometer. **(03)**
- 5C. Classify the wind tunnel according to flow velocity. Sketch a lab scale open (05) wind tunnel and explain the importance of each component.