Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

VI SEMESTER B.TECH. (AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, APRIL- 2018

SUBJECT: VEHICLE AERODYNAMICS [AAE 3251]

REVISED CREDIT SYSTEM
(16/04/2018)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. Classify the vehicle drag according to region of origin and explain the pressure distribution in longitudinal cross section of sharp and round edged vehicle. **(04)**

1B. Two common methods of improving fuel efficiency of a vehicle are to reduce the drag coefficient and the frontal area of the vehicle. Consider a car whose width (*W*) and height (*H*) are 1.85 m and 1.70 m respectively, with a drag coefficient of 0.30. Determine the amount of fuel and money saved per year as a result of reducing the car height to 1.55 m while keeping its width the same. Assume the car is driven 18,000 km a year at an average speed of 95 km/h. Take the density and price of gasoline to be 0.74 kg/L and 60 rupees/L, respectively. Also take the density of air to be 1.20 kg/m^3, the heating value of gasoline to be 44,000 kJ/kg, and the overall efficiency of the car's drive train to be 30 percent. **(04)**

1C. Define boundary layer concept and with suitable sketch effect of smooth and rough surface on boundary layer concept. **(02)**

2A. With suitable sketch explain the effect of hood inclination angle and front end inclination of a vehicle on drag coefficient of the passenger car. **(03)**

2B. Sketch and explain the effect of diffuser length on rear axle lift and drag of the vehicle. **(04)**

2C. 70-kg bicyclist is riding her 15-kg bicycle downhill on a road with a slope of 25^o without pedaling or braking. The bicyclist has a frontal area of 0.45 m^2 and a drag coefficient of 1.1 in the upright position, and a frontal area of 0.4 m^2 and a drag coefficient of 0.9 in the racing position. Disregarding the rolling resistance and friction at the bearings, determine the terminal velocity of the bicyclist for both positions. Take the air density to be 1.25 kg/m^3. **(03)**

3A. The aerodynamic drag of a new sports car is to be predicted at a speed of 60.0 mi/h at an air temperature of 25°C. Automotive engineers build a one-third scale model of the car to test in a wind tunnel. The temperature of the wind tunnel air is also 25°C. The drag force is measured with a drag balance, and the moving belt is used to simulate the moving ground (from the car's frame of reference). Determine how fast the engineers should run the wind tunnel to achieve similarity between the model and the prototype. For air at T = 25ºC and atmospheric pressure, ρ=1.184 kg/m^3 and μ= 1.849×10^{-5} kg/ms. **(03)**

3B. Define vehicle soiling. With suitable sketch explain the methods adopted in busses and trucks to reduce soiling. **(04)**

3C. Sketch and explain the effect of rear spoiler on drag and lift of the passenger vehicle. **(03)**

4A. Explain the effect of yaw angle on coefficient of drag of the passenger and commercial vehicles. **(04)**

4B. With suitable sketch explain the effect of cab to trailer body gap seals on drag coefficient of commercial vehicle. **(03)**

4C. Explain the working principle of hot wire anemometer. **(03)**

5A. With neat sketch explain the different jet boundary conditions used in wind tunnel. **(04)**

5B. Explain the effect of different car shapes on yawing moment and side force. **(03)**

5C. As shown in the Figure 1, a spoiler is used on race cars to produce a negative lift, thereby giving a better tractive force. The lift coefficient for the airfoil shown is 1.1, and the coefficient of friction between the wheels and the pavement is 0.6. At a speed of 200 mph, by how much would use of the spoiler increase the maximum tractive force that could be generated between the wheels and ground? Assume the air speed past the spoiler equals the car speed and that the airfoil acts directly over the drive wheels. **(03)**

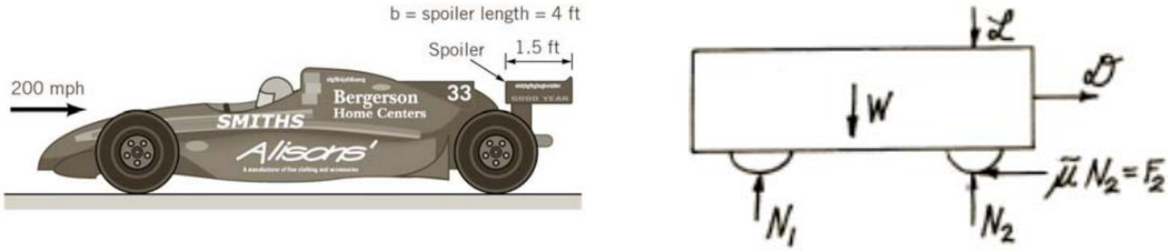

Figure 1