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

II SEMESTER, M. TECH (Automobile Engineering)
END SEMESTER EXAMINATION July 2022
COURSE:PE III VEHICLE AERODYNAMICS (AAE 5046)

Duration: 3 Hrs **Date: 01/07/2022** **MAX. MARKS: 50**

Note:

- *All questions are compulsory*
- *Draw a neat diagram wherever necessary*
- *Stepwise answers carry marks*

Q1A. What do you mean by the term 'Aerodynamics'? Explain its importance in Ground vehicles, Air vehicles with suitable examples. **[2]**

Q1B. With the help of neat diagram derive an expression for three dimensional flow continuity equation. **[3]**

Q1C. For the velocity profile for laminar boundary layer flows given as $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - 2\left(\frac{y}{\delta}\right)^3 + \left(\frac{y}{\delta}\right)^4$ obtain an expression for boundary layer thickness, shear stress, the drag force on one side of the plate, and coefficient of drag in terms of Reynolds number. **[5]**

Q2A. Describe the terms 'stream function' and 'velocity potential function'. **[2]**

Q2B. Derive an expression for measurement of pressure using vertical single column manometer. **[3]**

Q2C. The right limb of a simple U-tube manometer mercury is open to the atmosphere, while the left limb is connected to a pipe in which a fluid of sp. gravity 0.9 is flowing. The centre of pipe is 12 cm below the level of mercury in the right limb. Find the pressure of fluid in the pipe if the pressure difference of mercury level in the two limbs is 20 cm. **[5]**

Q3A. With the help of neat diagrams explain the concept of 'Notch back', 'Fast back' and 'Square back' in vehicle aerodynamics. **[5]**

Q3B. Heavy duty vehicle of an airfoil chord length 2m and of span 15 m has an angle of attack as 6^{o}. The airfoil is moving with a velocity of 80 m/s in air whose density is 1.25 kg/m^3. Find weight of the airfoil and the power required to drive it. The value of coefficient of drag and lift correspond to angle of attack are given as 0.03 and -0.5 respectively. **[5]**

Q4A. Explain how the 'vehicle frontal area' and 'boundary layer concept' in influences the performance of vehicle aerodynamics. **[5]**

Q4B. A heavy duty vehicle which weighs 29,430 N and has an area of 20 m^2 runs at a velocity of 250 km/hr., When the engine delivers 7375.5 KW. 65% of power is used to overcome the drag resistance of vehicle, calculate the coefficient of lift a coefficient of drag. Take the density of air 1.21 kg/m^3. **[5]**

Q5A. Explain with the suitable diagram the parts of wind tunnel and its functions. **[5]**

Q5B. Experiments were conducted in wind tunnel with a wind speed of 50 km/hr on a flat plate of size 2m long and 1m wide. The density of air is 1.5 kg/m^3. The coefficient of lift and drag is 0.75 and 0.15 respectively. Determine lift force, drag force, resultant force, direction of resultant force and power exerted by air on the plate. **[5]**