Exam Date & Time: 01-Jun-2023 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

VI Semester B.Tech. Automobile Engineering End Semester Examniation May/June 2023

VEHICLE AERODYNAMICS [AAE 4038]

Marks: 50 **Duration: 180 mins.**

Descriptive Questions

Answer all the questions. Section Duration: 180 mins

1) What factors affect the Comfort and Stability in vehicles from the perspective of aerodynamics? (2)

A)

B) Based on the studies of Klemperer, illustrate how side winds influence the stability of low-drag cars. (3)

C) Advertisement signs are commonly carried by taxicabs for additional income, but they also increase the fuel cost. Consider a sign that consists of a 0.4-m-high, 0.9-m-wide, and 0.9-m-long rectangular block mounted on top of a taxicab such that the sign has a frontal area of 0.4 m by 0.9 m from all four sides. Determine the increase in the annual fuel cost of this taxicab due to this sign. Assume the taxicab is driven 60,000 km a year at an average speed of 50 km/h and the overall efficiency of the engine is 28 percent. Take the density, unit price, and heating value of gasoline to be 0.72 kg/L, 110 Rs/L, and 42,000 kJ/kg, respectively, and the density of air to be 1.25 kg/m^3. (5)

2) Explain the effect of interference on the drag behaviour of two slender bodies placed (a) one behind the other with their respective axes coinciding (b) one above the other with their respective axes parallel. (4)

A)

B) The rear vane installed on the racing car is at an angle of attack of 8° and has characteristics as given in Figure 1. Estimate the downward thrust (negative lift) and drag force of the vane that is 1.75 m long and has a chord length of 250 mm. Assume the racing car travels at a speed of 300 km/h on a track where normal atmospheric pressure and a temperature of 30°C prevail.

(3)

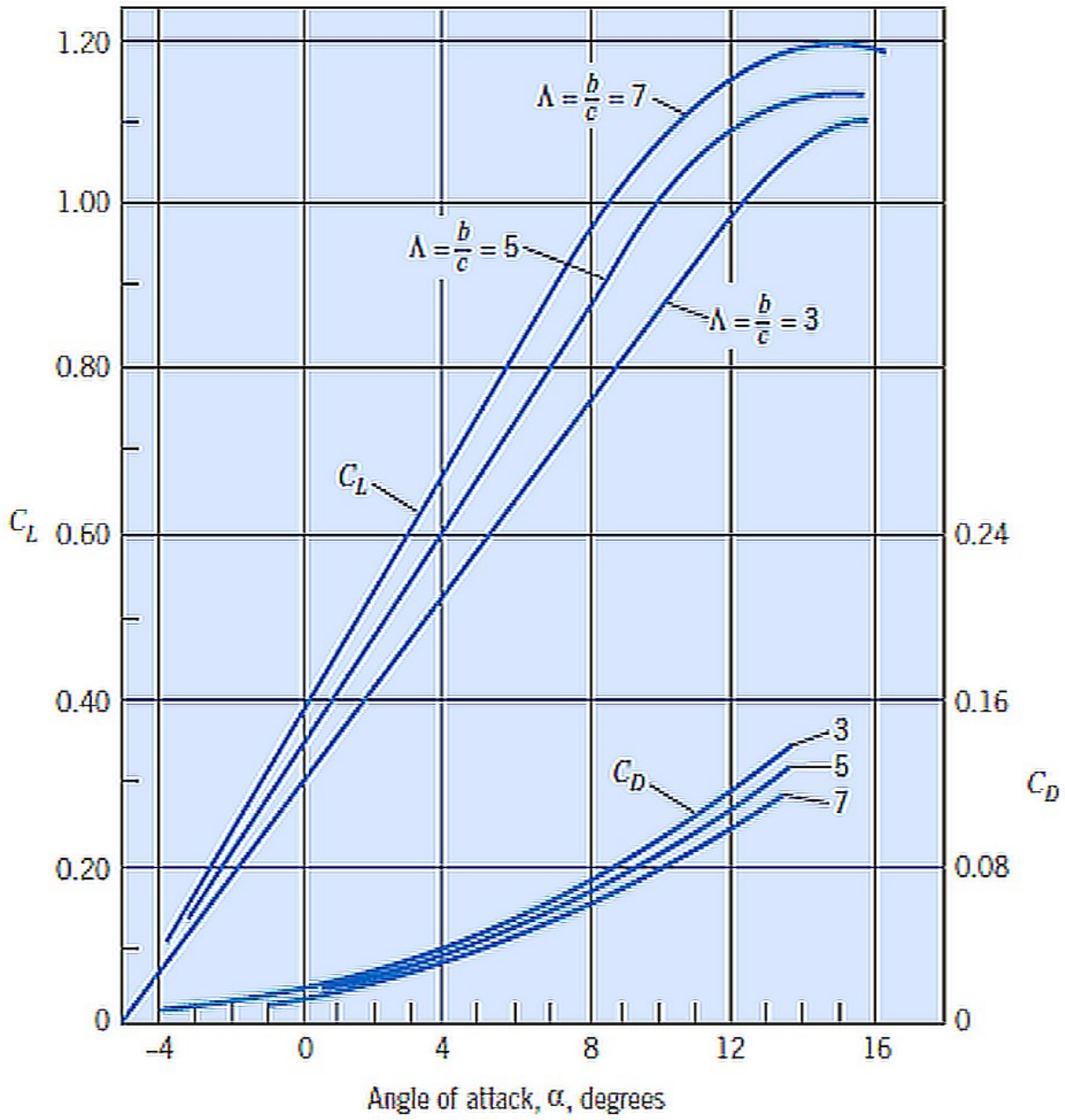
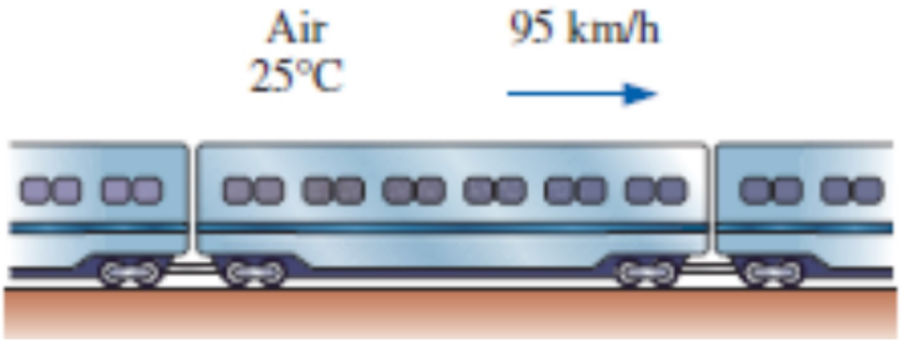
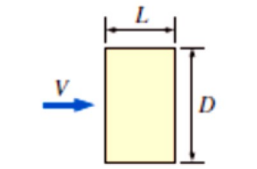


Figure 1 Drag and Lift coefficients for rear vanes of different aspect ratios

C) The top surface of the passenger car of a train moving at a velocity of 95 km/h is 2 m wide and 6 m long. If the outdoor air is at 1 atm and 25°C, determine the drag force acting on the top surface of the passenger cars. Use Figure 2 for necessary data.

(3)

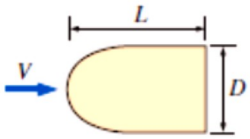




Sharp corners:

L/D	C_D
0.0*	1.9
0.1	1.9
0.5	2.5
1.0	2.2
2.0	1.7
3.0	1.3

* Corresponds to thin plate



Round front edge:

L/D	C_D
0.5	1.2
1.0	0.9
2.0	0.7
4.0	0.7

Figure 2 The drag coefficient across bodies with different aspect ratios

3) Illustrate the main separations during the flow of air around an entire sedan car and explain each in detail. (5)

A)

B) With the aid of neat diagrams, explain how the following affect the rolling resistance of vehicles: (i) Tire Construction (ii) Tire Inflation (iii) Tire Temperature. (3)

C) What is meant by acceleration resistance? (2)

4) Describe the modifications that can be carried out on the underbody of fastback cars to reduce the drag. (2)

A)

B) Compare the vortices on different rear-end shapes of cars. (4)

C) With labelled diagrams, explain the working of the following wind tunnels: (i) Eiffel type (ii) Gottiengen type. (4)

5) It is desired to measure the drag on an airplane whose velocity is 130 m/s. Is it feasible to test a $1/20^{th}$ scaled model of the plane in a transonic wind tunnel at the same pressure and temperature to determine the prototype drag coefficient? (3)

A)

B) Explain the detail optimizations that can be carried out on cars for improvement in aerodynamics. (5)

C) In climatic wind tunnels, how is the sun load simulated on vehicles? (2)

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