Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 91066

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Fifth Semester

Aeronautical Engineering

AE6503 – AERODYNAMICS – II

(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Use of gas tables and θ-β-M graph is permitted

Answer ALL questions

PART – A (10×2=20 Marks)

1. Define compressibility. When it can be neglected ?
2. Define Mach lines and Mach angle.
3. What are weak and strong oblique shocks ?
4. Define Fanno and Rayleigh flows.
5. State the assumptions made in small perturbation theory.
6. Write a short note on similarity rule.
7. Define drag-divergence Mach number.
8. Briefly explain shock-expansion theory and its importance.
9. State the principle of optical flow visualization techniques.
10. What is shock tube ?

PART – B (5×13=65 Marks)

11. a) Derive stream tube area-velocity relation and explain the information that can be derived from the area-velocity relation. (9+4)

(OR)

b) i) Air is compressed isentropically in a centrifugal compressor from a pressure of 1.0×10^5 Pa to a pressure of 6.0×10^5 Pa. The initial temperature is 290 K. Calculate the change in temperature and change in internal energy. (5)

ii) Draw the neat figure of propagation of disturbance waves created by an object moving with velocity V = 0, V = a/2, V = a and V > a and explain the various features of the flow regime that can be inferred from the figures. (Note : 'a' is the speed of sound). (8)

12. a) Derive Prandtl relation for a normal shock and explain the physical significance of the relation. (11+2)

(OR)

b) i) Explain Prandtl-Meyer expansion fan with a neat sketch. (7)

ii) An air stream flowing out of a convergent nozzle at 200 m/s and 30°C is made to enter an insulated pipe of diameter 20 mm. Determine the length of the pipe at which the flow will become sonic if the average friction factor is 0.02. (6)

13. a) Derive the basic nonlinear potential equation for compressible flow. (13)

(OR)

b) Define method of characteristics and state the compatibility relations. Describe with a neat figure, how method of characteristics is used to design supersonic nozzle with gradual expansion ? (6+7)

14. a) i) Explain transonic area rule with area distribution plot and C_D vs. M_∞ plot. (7)

ii) Explain the purpose of super critical airfoil. Compare (with a neat figure) the flow-field characteristics of standard NACA airfoil with a super critical Airfoil at cruise conditions. (2+4)

(OR)

b) For the flat plate shown in Figure 14(b), calculate the flow Mach numbers at zones 2, 2′, 3 and 3′, assuming the slipstream deflection to be negligible. (13)

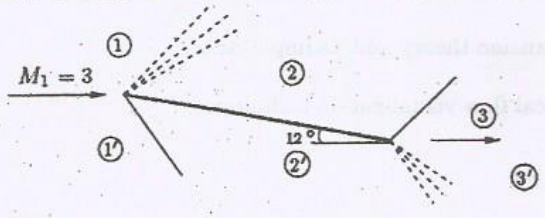

Figure 14(b)

15. a) Draw a neat sketch of shadow graph and Schlieren systems. And compare both the systems. **(8+5)**

(OR)

b) Explain the working of intermittent blow down tunnel with a neat schematic diagram. **(13)**

PART – C **(1×15=15 Marks)**

16. a) i) A blunt nosed pitot probe made of aluminium is placed in a supersonic air stream of temperature 30°C. If the melting temperature of aluminium is about 660°C, determine the flow velocity at which the probe will begin to melt. Assume air to be an ideal gas. **(8)**

ii) The blunt nosed pitot probe is now placed in the test section of supersonic wind tunnel to determine the flow Mach number. The total pressure at the entrance of the convergent-divergent nozzle is 2.774×10^5 Pa and the total pressure measured by the pitot tube is 2.0×10^5 Pa. By making suitable assumptions (with figures wherever applicable), determine the flow Mach number in the test section. **(4+3)**

(OR)

b) A convergent-divergent nozzle of throat area 10 cm^2 and exit area 24 cm^2 is run from an air storage tank at 300 KPa and 300 K. Calculate the range of back pressure for which :

a) The entire divergent portion will be supersonic and

b) The exit Mach number is less than 1

c) Are the mass flow and exit pressure independent of the back pressure ? **(15)**

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