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Question Paper Code : 40061

B.E. /B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Sixth Semester

Aeronautical Engineering

AE 8602 – EXPERIMENTAL AERODYNAMICS

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is understood by dynamic similarity of wind tunnel models?

2. Determine the absolute viscosity of air at temperatures 20 C and 30C.

3. What is the purpose of honey combs in wind tunnels?

4. Why are air heaters required in hypersonic wind tunnels?

5. What are the requirements of tracer particles used for flow visualization?

6. Differentiate Schlieren, shadowgraph and interferometry methods.

7. Why are hot wire anemometers preferred for measurement in the low velocity regimes?

8. What is seebeck effect?

9. Define Rossby number. State its significance.

10. Compare external estimate and internal estimate of errors.

PART B — (5 × 13 = 65 marks)

11. (a) Explain the various terms used to describe the performance of measurement systems.

Or

(b) Explain with neat sketch, the principle and operation of continuous supersonic wind tunnel. Also mention its merits and demerits.

12. (a) (i) The drag of a turbulence sphere in a subsonic wind tunnel test-section is measured to be 0.15 N. If the test-section speed is 45 m/s and the stagnation state is standard sea level condition, find the sphere diameter and the turbulence factor of the tunnel. (6)

(ii) An open-circuit subsonic wind tunnel of test-section area 1 m^2 draws atmospheric air at 1 atm and 30°C. (a) If a model of 4 percent blockage is tested at a test-section speed of 90 m/s, determine the change in mass flow rate per unit area, caused by the model blockage. (b) If the model blockage is 5 percent, how much would be the change in the mass flow rate per unit area? (7)

Or

(b) A two-dimensional, symmetric wedge of nose-angle 10 is placed, with its axis coinciding with the tunnel axis, in a Mach 2.2 tunnel.

(i) If the pressure coefficient over the upper surface of the wedge is — 0.0347, find the flow angularity in the test-section, with respect to the tunnel axis.

(ii) If there is no flow angularity, what will be the pressure coefficient over the upper surface of the wedge? Also, find the Mach number of the flow over the upper surface.

13. (a) What are the desired properties of smoke for flow visualization? Also explain any two smoke production methods for smoke flow visualization.

Or

(b) With neat illustration, State and prove Hele—Shaw analogy.

14. (a) A pitot probe has to be designed for measurement in a Mach 2 air stream.

(i) If the probe blockage should not cause more than 1 percent error to the flow Mach number, what should be the ratio of the flow field area to the probe projected area?

(ii) What will be the error in the flow Mach number measured, due to this probe blockage, in Mach 3, 1.5, and 1.2 flows of the same flow cross-Sectional area as the Mach 2 flow field?

(iii) From these error estimates will it be possible to identify the probe blockage which will cause only acceptable error to the Mach number over the entire range of supersonic flow beginning from Mach 1.5?

Or

(b) (i) Calculate the dynamic pressure of a flow with free stream conditions of velocity 210 m/s, pressure 1 atm, and temperature 310 K. What will be the percentage error if the flow is treated as incompressible? (6)

(ii) A gas thermometer was calibrated by placing the bulb in melting ice at $0^{\circ}C$ and difference in height of the mercury column was 820mm. the bulb was then placed in steam at $100^{\circ}C$ and the mercury column was adjusted to be1300 mm. The bulb was then placed in a fluid of unknown temperature and, after adjustment, the difference in height of the mercury column read was 97 cm. Determine the temperature of the fluid. (7)

15. (a) Explain the following with neat illustration

(i) Explain How do you carry out measurements in boundary layer. (6)

(ii) Explain the procedure for calculating measurement errors (7)

Or

(b) (i) Write down the general procedure adopted for uncertainties in the measured data. (6)

(ii) State and prove Taylor Proudman Theorem with aid of sketch the experimental setup. (7)

PART C — (1 × 15 = 15 marks)

16. (a) (i) An experimental rocket powered aircraft is flying at a velocity of 1035 m/s at an altitude corresponding to 0.720 x 10^5 N/m^2 and 216.6 K. A pitot tube is mounted in the nose of the aircraft. What is the pressure measured by the Pitot tube? What is the pressure measured if the aircraft is assumed to fly at 210 m/s at the same altitude. (12)

(ii) If the density ratio across the shock at the nose of a vehicle flying at a very high hypersonic speed is 18, assuming the fluid as perfect gas, determine the value of specific heats ratio. (3)

Or

(b) (i) The pressure and temperature of an air stream are measured as 650 mm of mercury and 32°C, respectively. If the fluctuation in the pressure is 2mm of mercury and error in the temperature measured is 0.1°, determine the uncertainty in the density calculated using thermal state equation.

(ii) In an experiment to determine the temperature and the associated flow quantities, a total temperature probe of recovery factor 0.9 was used. The probe gave a temperature value of 650K. The static temperature is known to be 240K. Find the Mach number of the flow.

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