

AE 2353 / WIND TUNNEL TECHNIQUES

1. (a) **State** Buckingham's π -theorem.

(b) The efficiency η of an depends on density ρ , dynamic viscosity μ of the fluid, angular velocity diameter D of the rotor and the discharge Q . Express η in terms of dimensionless parameters. (A.M.I.E., Winter, 1976).

2. Using Buckingham's π - theorem, show that the velocity through a circular orifice is given by

$$V = \sqrt{2gH} \phi \left[\frac{D}{H}, \frac{\mu}{\rho V H} \right], \text{ where } H \text{ is the head causing flow, } D \text{ is the diameter of the orifice, } \mu \text{ is co-}$$

efficient of viscosity, ρ is the mass density and g is the acceleration due to gravity. (A.M.I.E., Winter, 1977)

3. A pipe of diameter 1.5m is required to transport an oil of sp. Gr. 0.90 and viscosity 3×10^{-2} poise at the rate of 3000 litre/s. Tests were conducted on a 15cm diameter pipe using water at 20°C . Find the velocity and rate of flow in the model. Viscosity of water at 20°C =0.01 poise.

4. A ship 300m long moves in sea- water, whose density is 1030 kg/m^3 , A1:100 model of this ship is to be tested in a wind tunnel around the model is 30m/s and the resistance of the model is 60N. Determine the velocity of ship in sea- water and also the resistance of the ship in sea – water. The density of air is given as 1.24 kg/m^3 . Take the kinematic viscosity of sea – water and air as 0.012 strokes and 0.018 strokes respectively.

5. The pressure drop in an aero plane model of size $\frac{1}{10}$ of its prototype is 80 N/cm^2 . The model is tested in water. Find the corresponding pressure drop in the prototype. Take density of air = 1.24 kg/m^3 . The viscosity of water is 0.01 poise while the viscosity of air is 0.00018 poise.

6. Explain the following non – dimensional numbers.

- a) Reynolds number b) Froude's number
- c) Euler's number d) Weber's Number
- e) Mach's number

7. With help of a neat sketch explain about the double return Wind tunnel?

8. With help of a neat sketch explain about the open circuit Wind tunnel?

9. Write about emerging techniques in wind tunnel history?

1. Explain in detail Helium and gun tunnels?

2. Explain in detail Blow down and in draft tunnel layouts.

3. With help of a neat sketch explain hypersonic Wind tunnel?

4. Write the process to calibrate pressure gauge for a supersonic wind tunnel?

5. Write the process to calibrate supersonic wind tunnel?

6. What is turbulence and what are turbulence effects in wind tunnel and how can we measure that?

7. Explain hot wire anemometer in detail?

8. Explain pressure and temperature measurement techniques?

9. Explain in detail six component balance system?

10. Explain in detail smoke and tuft grid generation techniques of flow visualization/?

11. Write about the dye injection techniques?
12. Explain Schlieren system of optical flow visualization?
13. Explain Interferometer technique of flow visualization in detail?
14. Explain shadowgraph technique in detail?
15. Explain in detail Laser Doppler anemometer/?
16. Write about Particle image velocimetry?
17. Explain about Laser induced fluorescence?
18. Explain briefly about open circuit wind tunnel?
19. Explain briefly about closed circuit wind tunnel?
20. Explain the tuft grid visualization with neat sketch.
21. Write the process to calibrate pressure gauge for a Hypersonic wind tunnel?
22. Explain briefly about transonic wind tunnel?
23. Explain about the types of balances?
24. Write about Laser induced fluorescence?
25. Write a neat sketch explain the working principle of a shock tube.

