UNIT V DIMENSIONAL ANALYSIS AND MODEL STUDIES

PART - A

1. Define dimensional analysis.
2. What are the fundamental dimensions?
3. Give the dimensions of Area and Volume.
4. Derive the dimensions of velocity.
5. Define Model.
6. List out the advantages of model analysis.
7. Define similitude.
8. Define Scale ratio.
9. Define dynamic similarity.
10. Give the types of forces in a moving fluid.
11. Define dimensionless numbers.

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12. *Define* surface tension.
13. Define pressure force.
14. Define Elastic force.
15. Give the types of dimensionless numbers.
16. Define Reynold's number.
17. Define Froude's number.
18. Give the classification of models.
19. What is an undistorted model?
20. What id distorted model?
21. Give the advantages of distorted models.
22. List out the types of model laws.
23. List out the application of Froude's model laws.
24. Define Weber's model laws.

PART - B

1. Explain Buckingham's theorem.
2. The resisting force (R) of a supersonic flight can be considered as dependent upon length of aircraft (l), velocity (V), air viscosity 'μ', air density 'ρ', and bulk modulus of air ' k'. Express the functional relationship between these variables and the resisting force.
3. A ship is 300 m long moves in sea water, whose density is 1030 kg/m^3. A 1:100 model of this to be tested in a wind tunnel. The velocity of air in the wind tunnel around the model is 30 m/s and the resistance of the model is 60 N. 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 stokes and 0.018 stokes respectively.
4. A 7.2 m height and 15 m long spillway discharge 94 m^3/s, under a head of 2.0m. If a 1:9 scale model of this spillway is to be constructed, determine model dimensions, head over spillway model and the model discharge. If model experience a force of 7500 N (764.53 Kgf), determine force on the prototype.
5. A quarter scale turbine model is tested under ahead of 12 m. The full scale turbine is to work under a head of 30 m and to run at 428 rpm. Find N for model. If model develops 100 kW and uses 1100 l/s at this speed, what power will be obtained from full scale turbine assuming its n is 3% better than that of model.
6. Using Buckingham's π theorem, show that the drag force $F_D = \rho L^2V^2\varphi$ (Re,M) which Re = ρ LV/μ; M = V/C; ρ = fluid mass density; L = chord length: V= velocity of aircraft; μ = fluid viscosity; C = sonic velocity = √K/ ρ where K = bulk modulus of elasticity.
7. The resistance ' R' experienced by apartially, submerged body depends upon the velocity 'V', length of the body 'l', viscosity of fluid 'μ', density of the fluid 'ρ', and gravitational acceleration 'g'; obtain expression for R.
8. Derive the relation using Buckingham's π theorem $F = \rho U^2D^2 f(\mu/UD\rho)$, ND/U).

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9. State the reasons for construction distorted model of rivers and discuss the various types of distortion in models. What are the merits and demerits of distorted models as compared to undistorted model?
10. In an aeroplane model of size 1/10 of its prototype the pressure drop is 7.5 kN/m^3. The model is tested in water. Find the corresponding pressure drop in the prototype. Take density of air is 1.4 kg/ m^3, density of water is 1000 kg/ m^3, viscosity of air is 0.00018 poise and viscosity of water is 0.01 poise.