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Question Paper Code : 80203

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Third Semester

Mechanical Engineering

CE 6451 — FLUID MECHANICS AND MACHINERY

(Common to Aeronautical Engineering, Automobile Engineering, Mechatronics Engineering, Mechanical and Automation Engineering and Production Engineering, Also common to Fourth Semester Industrial Engineering, Industrial Engineering and Management and Manufacturing Engineering)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Any missing data can be suitably assumed

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write down the effect of temperature on viscosity of liquids and gases.

2. Calculate the capillary rise in a glass tube of 2.5 mm diameter when immersed vertically in (a) water and (b) mercury. Take surface tension σ = 0.0725 N/m for water and σ = 0.52 N/m for mercury in contact with air. The specific gravity for mercury is given as 13.6 and angle of contact = 130°.

3. Find the displacement thickness for the velocity distribution in the boundary layer given by $u / U = 2\left(y / \delta\right) - \left(y / \delta\right)^2$.

4. Draw the velocity distribution and the shear stress distribution for the flow through circular pipes.

5. State Buckingham's π theorem. Why this method is considered superior to Rayleigh's method?

6. Derive the scale ratio for velocity and pressure intensity using Froude model law.

7. What is meant by priming of a centrifugal pump? Why is it necessary?

8. What is the function of air vessel in reciprocating pumps?

9. Explain the type of flow in Francis turbine.

10. What is draft tube?

PART B — ($5 \times 13 = 65$ marks)

11. (a) (i) Derive the Reynold's Transport theorem. (6)

(ii) The dynamic viscosity of an oil used for lubrication between a shaft and sleeve is 6 poise. The shaft is of diameter 0.4 m and rotates at 190 rpm. Calculate the power lost in the bearing for a sleeve length of 90 mm. The thickness of oil film is 1.5 mm. (7)

Or

(b) Derive the Bernoulli's equation with the basic assumptions. (13)

12. (a) Derive the Hagen Poiseuille formula for the flow through circular pipes. (13)

Or

(b) Three pipes of 400 mm, 200 mm and 300 mm diameters have lengths of 400 m, 200 m and 300 m respectively. They are connected in series to make a compound pipe. The ends of this compound pipe are connected with two tanks whose difference of water levels is 16 m. If the coefficient of friction for these pipe is same and equal to 0.005, determine the discharge through the compound pipe neglecting first the minor losses and then including them. (13)

13. (a) (i) The pressure difference Δp in a pipe of diameter D and length l due to turbulent flow depends on the velocity v, viscosity μ, density ρ and roughness k. Using Buckingham's π theorem, obtain an expression for Δp. (7)

(ii) Define similitude and explain its types. (6)

Or

(b) (i) The pressure drop in an airplane model of size 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)

(ii) Derive the five different types of dimensionless numbers. (7)

14. (a) Derive the expression for pressure head due to acceleration in the suction and delivery pipes of the reciprocating pumps. (13)

Or

(b) The internal and external diameter of an impeller of a centrifugal pump which is running at 1200 rpm are 300 mm and 600 mm. The discharge through the pump is $0.05\ m^3/s$ and the velocity of the flow is constant and equal to $2.5\ m/s$. The diameters of the suction and delivery pipes are 150 mm and 100 mm respectively and suction and delivery heads are 6 m(abs) and 30 m(abs) of water. If the outlet vane angle is 45° and power required to drive the pump is 17 kW determine :

(i) Vane angle of the impeller at inlet

(ii) Overall efficiency of the pump

(iii) Manometric efficiency of pump. (13)

15. (a) (i) Describe the efficiencies of a turbine. (6)

(ii) Explain the working of Kaplan turbine. Construct its velocity triangles. (7)

Or

(b) The following data is given for Francis turbine : Net Head = 60 m, speed = 700 rpm, shaft power = 294.3 kW, $\eta_0 = 84\%$, $n_h = 93\%$, flow ratio = 0.2, breadth ratio = 0.1, outer diameter of the runner = 2 inner diameter of runner. The thickness of vanes occupies 5% of the circumferential area of the runner. Velocity of flow is constant at inlet and outlet and discharge is radial at outlet. Determine :

(i) The guide blade angle

(ii) Runner vane angle at the inlet and outlet

(iii) Diameter of the runner at inlet and outlet

(iv) Width of the wheel at inlet. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Find the displacement thickness, the momentum thickness and the energy thickness for the velocity distribution in the boundary layer given by $u/U = 2\left(y/\delta\right) - \left(y/\delta\right)^2$. (15)

Or

(b) (i) Explain the Reynold's Experiment. (5)

(ii) Derive the Darcy – Weisbach equation for the loss of head due to friction in Pipes. (10)