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Question Paper Code : 80075

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY, 2019.

Third/Fourth Semester

Industrial Engineering

CE 8394 — FLUID MECHANICS AND MACHINERY

(Common to Industrial Engineering and Management/Aeronautical Engineering/Automobile Engineering/Manufacturing Engineering/Mechanical Engineering/Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering/Mechatronic Engineering/Production Engineering)

(Regulation 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish between Hook's law of solid with Newton's law of viscosity of fluid

2. State the assumptions in deriving Bernoulli's equation.

3. Hypothetically, under what conditions, minor losses will be higher than major loss?

4. What is HGL and TEL?

5. State the advantages of dimensional analysis.

6. List the areas in which model studies is applied.

7. State the Euler's equation of hydrodynamic machines.

8. How NPSH affects the cavitation in centrifugal pump?

9. Draw the outlet triangle for turbine when the jet angle is = 90°.

10. Define specific speed and write its equation for turbines.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Derive the differential equation for three dimensional continuity flows in cartesian coordinates. (9)

(ii) Calculate the dynamic viscosity of oil, which is used for lubrication between a square plate of size 0.8 m × 0.8 m and an inclined plane with angle of inclination 30 degree to horizontal. The weight of the square plate is 300 N and slides down with uniform velocity of 0.3 m/s. The thickness of oil film is 1.5 mm. (4)

Or

(b) The inlet and throat diameters of a vertically mounted venturimeter are 30 cm and 15 cm, respectively. The throat section is below the inlet section at a distance of 10 cm. The density of the liquid is 850 kg/m^3 .The intensity of pressure at inlet and throat are 150 kN/m^2 and 90 kN/m^2 respectively. If 4% of the differential head is lost between inlet and throat, find the volumetric flow rate. (13)

12. (a) Two reservoirs with a difference in water surface elevation of 10 m are connected by a pipeline ABC which consists of two pipes of AB and BC joined in series. Pipe AB is 10 cm in diameter and 20 m long and has a value of friction factor $f = 0.02$. Pipe BC is of 16 cm diameter, 25 m long and has $f = 0.018$.

(i) Calculate the discharge and

(ii) Determine the difference in reservoir elevations necessary to have a discharge of 15 lit/s.

Include all losses for both the cases. (13)

Or

(b) Derive an expression for steady laminar flow in circular pipes and prove that the $U_{max}/V = 2$. Draw the necessary sketches. (13)

13. (a) The power P developed by a water turbine depends on the rotational speed N, operating head H, gravity g, diameter D and width B of the runner, density ρ and viscosity μ of water. Show by dimensional analysis that $P = \rho D^5 N^3 \Phi \left[H/D, D/B, \rho D^2 N/\mu, ND/\sqrt{gH} \right]$. (13)

Or

(b) (i) A 1:10 scale model of a submarine moving far below the surface of sea water is tested in a water tunnel, If the speed of the prototype is 8 m/s, determine the corresponding velocity of water in the tunnel. Also determine the force ratio of the model and the prototype. Kinematic viscosity of seawater and water are 1.121×10^{-6} m^2/s and 10^{-6} m^2/s respectively. Density of seawater is 1027 kg/m^3. (6)

(ii) A ship 170 m long moves in fresh water at 40 km/hr. A 1:100 model of this ship is to be tested in a towing basin containing a liquid of sp.gr.0.90. What is the viscosity of liquid (model)? At what speed must the model be towed? If 120 Watts is required to tow the model at this speed, what power is required by the ship? Take viscosity of water as 0.00113 Ns/m^2. (7)

14. (a) A centrifugal pump lifts water against a static head of 32.067 m of which 3.054 m is suction lift. Both the suction and delivery pipes are 12.7 cm in diameter. The loss of head in suction pipe is 1.07 m of water and in delivery pipe is 5.955 of water. The impeller is 30.54 cm in diameter and 2.54 cm wide at the outlet. It revolves at 1450 rpm and the blade angle at exit is 35°. The manometric efficiency of the pump is 80% and its overall efficiency is 68%. Determine (i) The discharge of the pump, (ii) The power required to drive the pump and (iii) The pressures at the two branches of the pipe. Neglect the effect of vane thickness on the area of the flow.

Or

(b) (i) Write the different classifications of rotary pumps and explain the working principle of any one. (8)

(ii) Explain the working of a double acting reciprocating pump with a neat sketch. (5)

15. (a) A double jet Pelton wheel is required to generate 7500 KW. When the available head at the base of the nozzle is 400 m. The jet is deflected to 165° and the relative velocity of the jet is reduced by 15% in passing over the buckets. Determine the diameter of the jet, total flow rate and force exerted by the jet in tangential direction. Assume generator efficiency = 95%, overall efficiency = 80%, speed ratio = 0.47 and CV = 0.97. (13)

Or

(b) (i) With a neat sketch explain the function of Francis turbine. (8)

(ii) Discuss the need of draft tube for turbine. (5)

PART C — (1 × 15 = 15 marks)

16. (a) A pumping plant is forcing the water through a pipe of 60 cm diameter and frictional loss is 30 m. For reducing the power consumption, it is proposed to lay another pipe along the side of existing pipe so both pipes will run parallel for the entire length and reduces the friction head to 10 m. Find the required diameter of new pipe line assuming friction factor is same for both pipe lines.

Or

(b) The diameter of a pipe bend is 0.35 m at inlet and 0.2 m at outlet and the flow is turned through 135° in a vertical plane. The axis at inlet makes an angle of 50° to horizontal plane and the centre of the outlet section is 1 m above the centre of the inlet section. The total volume of fluid contained in the bend is 0.12 m^3. Due to losses of energy between inlet and outlet 0.2 m of head is lost. Calculate the magnitude and direction of the force exerted on the bend by the water flowing through it at 230 lit/s when the inlet pressure is 150.78 kN/m^2.