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Question Paper Code : X10238

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020 AND APRIL/MAY 2021

Third/Fourth Semester

Mechanical Engineering

CE 8394 – FLUID MECHANICS AND MACHINERY

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

(Regulations 2017)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Differentiate between a 'liquid' and a 'gas'.
2. List the various forms of energies possessed by the fluid flowing in a pipeline.
3. Define nominal thickness of the boundary layer.
4. What do you mean by 'Pipes in series' ?
5. Under what conditions, a model and the corresponding prototype are said be kinematically similar.
6. State any two uses of dimensional analysis in the study of fluid mechanics.
7. Write down the relationship between absolute velocity of jet at inlet to impeller blades, peripheral velocity of pump impeller at inlet and relative velocity of jet at inlet to impeller blades.
8. Classify the types of impellers.
9. Define specific speed of a turbine.
10. The casing of a Pelton turbine has no hydraulic function to perform. Why ?

PART – B **(5×13=65 Marks)**

11. a) i) Discuss the factors influencing the bulk modulus of elasticity of a fluid. Liquids are generally considered incompressible. Why ? **(6)**

ii) A tape of 0.015 cm thick and 1.00 cm wide is to be drawn through a gap with a clearance of 0.01 cm on each side. A lubricant of dynamic viscosity 0.021 N s m^{-2} completely fills the gap for a length of 80 cm along the tape. If the tape can withstand a maximum tensile force of 7.5 N calculate the maximum speed with which it can be drawn through the gap. **(7)**

(OR)

b) i) The four types of flows namely, steady, unsteady, uniform and non-uniform flows can exist independent of each other. Enlist the four types of combinations of these flows that are possible and provide a common example for each of the listed combinations of flows. **(2+4)**

ii) Water flows through a pipe AB 1.2 m in diameter at 3 m s^{-1} and then passes through a pipe BC which is 1.5 m in diameter as shown in figure 1. At C the pipe branches. Branch CD is 0.8 m in diameter and carries one-third of the flow in AB. The velocity in branch CE is 2.5 m s^{-1}. Find (a) the volume rate of flow in AB, (b) the velocity in BC, (c) the velocity in CD, (d) the diameter of CE. **(7)**

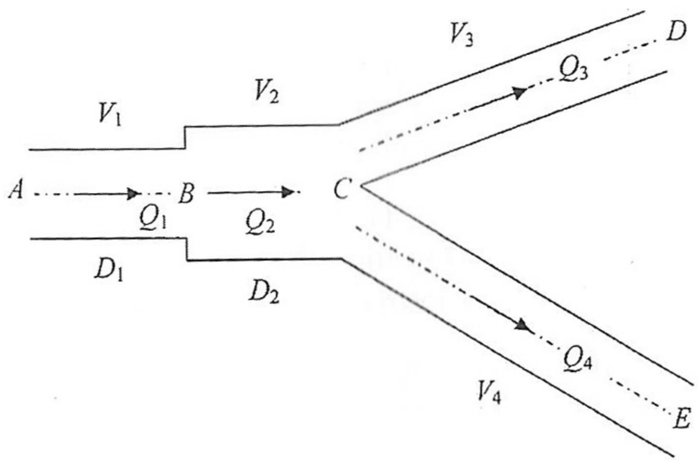

Figure 1 Q. 11(b) (ii)

12. a) i) With a neat sketch, explain "Pipes in parallel". **(6)**

ii) A 150 mm diameter pipe reduces in diameter abruptly to 100 mm. If the pipe carries water at 30 litres s^{-1}, calculate the pressure loss across the contraction and express this as a percentage of the loss to be expected if the flow was reversed. Take the coefficient of contraction as 0.6. **(7)**

(OR)

b) i) With the help of a figure, explain the development of boundary layer along a long thin flat plate, illustrating variations in boundary layer thickness. **(6)**

ii) Water at a density of 998 kg m^{-3} and kinematic viscosity of 1×10^{-6} m^2 s^{-1} flows through smooth tubing at a mean velocity of 2 m s^{-1}. If the tube diameter is 30 mm, calculate the pressure gradient per unit length necessary. Assume that the friction factor for a smooth pipe is given by 16/Re for laminar flow and $0.079/Re^{1/4}$ for turbulent flow. **(7)**

13. a) i) State Fourier's principle of dimensional homogeneity. When is an equation said to be dimensionally homogeneous ? Illustrate dimensional homogeneity using the expression for discharge of a rectangular weir given by $Q = (2/3)\, C_d (2g)^{1/2}\, LH^{3/2}$, where C_d is the coefficient of discharge of the weir (has no units), g is the acceleration due to gravity, L is the length of the weir and H is the head causing flow over the weir. **(1+1+4)**

ii) Show by Rayleigh method that the resistance R to the motion of a sphere of diameter D moving with a uniform velocity V through a fluid having density ρ and viscosity μ may be expressed as

$$R = \left(\rho D^2 V^2\right) \phi\left(\frac{\mu}{\rho V D}\right).$$ **(7)**

(OR)

b) i) Under what conditions, a model and its prototype are said to be (1) geometrically similar, (2) kinematically similar and (3) dynamically similar. **(6)**

ii) In order to estimate the frictional head loss in a pipe 1 m in diameter, through which castor oil of specific gravity 0.96 and dynamic viscosity 9.9 poise, is to be transported at the rate of 5000 litres per second, a test was conducted on a pipe of diameter 50 mm using water at 15°C as the model fluid. Calculate the discharge required for the model pipe. **(7)**

14. a) i) Explain the difference between 'manometric head' and 'total head'. Provide expressions for manometric head and total head. **(6)**

ii) A centrifugal pump draws water from a sump through a vertical 150 mm pipe. The pump has a horizontal discharge pipe 100 mm diameter which is 3.5 m above water level in the sump. While pumping 35 litres per second, gauges near the pump at entrance and discharge read $-0.35\ kg_f\, cm^{-2}$ and $+1.8\ kg_f\, cm^{-2}$ respectively. The discharge gauge is 0.5 m above the suction gauge. Determine the power output of the pump. **(7)**

(OR)

b) i) What are the main components and action of a reciprocating pump ? Why a reciprocating pump is called a positive displacement pump ? **(6)**

ii) A square plate weighing 140 N and of uniform thickness and 300 mm edge is hung so that it can swing freely about the upper horizontal edge. A horizontal jet of water 20 mm in diameter and having a velocity of 15 m s^{-1} impinges on the plate. The center line of the jet is 150 mm below the upper edge of the plate and when the plate is vertical the jet strikes the plate at its centre in the direction perpendicular to the plate. Find the force that must be applied at the lower edge of the plate in order to keep it vertical. **(7)**

15. a) i) Enumerate the main components of Pelton turbine and briefly state their functions. **(6)**

ii) An experimental inward flow reaction turbine rotates at 370 rpm. The wheel vanes are radial at inlet and the inner diameter of the wheel is half the outer diameter. The constant velocity of flow in the wheel is 2 m s^{-1}. Water enters the wheel at an angle 10°04' to the tangent to the wheel at inlet. The breadth of the wheel at inlet is 75 mm and the area of flow blocked by vanes is 5% of the gross area of flow at inlet. Find the outer and inner diameters of the wheel. **(7)**

(OR)

b) i) What is a draft tube ? Explain its functions. **(6)**

ii) In a Pelton wheel, the diameter of the bucket circle is 2 m and the deflecting angle of the bucket is 162°. The jet is of 165 mm diameter, the pressure head behind the nozzle is 1000 kN m^{-2} and the wheel rotates at 320 rev min^{-1}. Neglecting friction, find the power developed by the wheel. **(7)**

PART – C **(1×15=15 Marks)**

16. a) A twin jetted Pelton wheel is required to generate 7,600 kW when the available head is 420 m. Assuming generator efficiency of 95%, overall efficiency of 80%, coefficient of velocity of jet issued through nozzle 0.98, speed ratio 0.46, reduction in relative velocity while passing through the bucket as 15% and deflection angle of the jet as 165°. Find (i) diameter of each jet, (ii) discharge, (iii) force exerted by the jet on buckets in tangential direction. **(15)**

(OR)

b) A ship 150 m long moves in fresh water at 15°C at 36 km/h. A 1:100 model of this ship is to be tested in a towing basin containing a liquid of specific gravity 0.90. What viscosity must this liquid have for both Reynolds and Froude model laws to be satisfied ? At what speed must the model be towed ? If 117.7 watts is required to tow the model at this speed, what power is required by the ship ? Dynamic viscosity of water at 15°C is 1.13×10^{-3} N.S/m^2. **(15)**
