Ref. No Ex/Prod/T/224/2019

B.E. PRODUCTION 2ND YEAR 2ND SEM EXAMINATION 2019

Subject: FLUID MACHINES Time : THREE HOURS Full Marks :100

Answer any five questions

1(a) What is a symmetrical vane ? Find the resultant force exerted on a symmetrical stationary vane when jet of water strikes the vane centrally. (6)

(b) A jet of water having a velocity 17 m /s strikes tangentially at one of the tips of a single symmetrical curved vane that moves with a velocity 8 m/s. The vane is so shaped that jet is deflected through a angle 118° . Determine
(i) The angle of the jet at the inlet which makes with the direction of motion of the vane.
(ii)The magnitude and direction of absolute velocity of jet at outlet ?
(iii)Work done per unit weight of water.
(iv) Also draw the velocity diagrams at inlet and outlet
Assume vane is perfectly smooth. (8)

(c) A lawn sprinkler as shown in fig 1 has two nozzles of diameters 8 mm each at the end of its rotating arm and the velocity of flow of water from each nozzle is 12 m/s . If the nozzles are at a distance of 40 cm from the centre of the rotating arm , determine
(i) The torque required to hold the rotating arm stationary.
(ii) Constant speed of rotational arm (in R P M), if it is free to rotate. (6)

2(a) With the help of neat simple line sketch explain the function of nozzle with a regulating spear to control the amount of water that strikes the bucket of a Pelton wheel turbine. (6)

(b) Show that in a Pelton wheel turbine the hydraulic efficiency is given by
$\eta_{hyd} = [\,2(V-u)(1+k\cos\theta)u\,]/V^2$
Where , u : Velocity of the wheel (bucket)
V : Velocity of jet
θ : Outer vane angle
k : friction factor
Hence find the bucket speed (u) in terms of jet speed (V) for maximum efficiency . (8)

(c) With the help of schematic diagram explain the different losses and efficiencies of a turbine. (6)

[Turn over

3(a) " Francis turbine is a Reaction turbine " . Explain briefly. (5)

(b) The following data is available for a Francis turbine : Net head = 70m , speed = 600 RPM , Shaft power = 367.875 kW , η_o (overall efficiency) = 85% , η_h (hydraulic efficiency) = 95% , flow ratio at inlet =0.25 , the ratio of the width of the blade to diameter at inlet = 0.1, outer diameter of the runner is 2 times that of inner diameter. The thickness of the vanes occupies 10% of the circumferential area of the runner. If the velocity of flow is constant at inlet and outlet , determine : (i) Guide blade angle , (ii) Runner vane angles at inlet and outlet (iii) Diameter of the runner at inlet and outlet and (iv) Width of wheel at inlet. Assume radial discharge at outlet (8)

(c) Name (only) different characteristic curves of a turbine. Explain with neat diagram how to construct a Muschel curve (constant efficiency curve) of the turbine. (7)

4(a) Distinguish between a tangential turbine and axial flow turbine . (Give at least *five* major differences) (5)

(b) State the functions of a draft tube and also sketch *Four* different types of draft tube. (7)

(c) A conical draft tube having inlet and outlet diameters are 0.8 and 1.2 m respectively discharges water at outlet with a velocity of 3 m/s . The total length of the draft tube is 8 m and 2 m of the length of the draft tube is immersed in water. If the atmospheric pressure head is 10.3 m of water and loss of head due to friction in the draft tube is equal to 0.25 times the velocity head at outlet of the tube , find (i) Absolute Pressure head at inlet (ii) Efficiency of the draft tube. (8)

5(a) Define a centrifugal pump. Explain the different types of heads in centrifugal pump. (5)

(b) What are the advantages of multistage pump over single stage pump. Explain with neat sketches different types of multistage pump. (7)

(c) The internal and external diameter of an impeller of a centrifugal pump which is running at 1000 R P M are 250 mm and 500 mm respectively. The discharge through the pump is 0.06 m^3 / s and velocity of flow is constant and equal to 3 m / s. The diameters of the suction and delivery pipes are 125 mm and 75 mm respectively and suction and delivery piezometric heads are 5 m (abs) and 30 m (abs) of water respectively. If the outlet vane angle is 45° and power required to drive the pump is 17kW, determine (i) vane angle at inlet (ii) Overall efficiency (iii) manometric / hydraulic efficiency. (8)

6(a) Define unit discharge for a turbine and derive a formal expression for it. (4)

(b) In a hydroelectric generating plant , there are three similar turbines of total output 150,000 kW. The overall efficiency of each turbine is 85% and runs at 150 RPM under the head of 55 m. It is proposed to test the model of the above turbine in a flume where discharge is 300 lit/s under head of 3 m. Find the size and the speed of the model. Derive the necessary formula / formulae you have used (8)

(c) The diameter of a centrifugal pump which discharges 0.035 m^3 / s of water against a total head of 25 m is 0.05 m. The pump is running at 1200 RPM. Find the discharge and the ratio of powers of a geometrically similar pump of diameter 0.03 m when running at 2000 RPM. Deduce the necessary formula / formulae you have used. (8)

7(a) With the help of neat sketch explain briefly the functions of air vessel in a single acting reciprocating pump. (7)

(b) Define negative slip of a reciprocating pump. When and why does it occur? (5)

(c) A single acting reciprocating pump running at 150 R P M. is fitted with an air vessel at its suction side very near to the cylinder. The diameter and stroke length of the cylinder are 100 mm and 400 mm respectively. Find the rate of flow from or into the air vessel when crank makes an angle 10° and 80° with the inner dead centre. Find also the crank angles at which no flow occurs from or into the air vessel. (8)

8(a) With the help of neat sketch explain the working principle of hydraulic ram. (5)

(b) An accumulator is loaded with 50 kN weight. The ram has a diameter of 40 cm and stroke of 7m . Its friction may be taken as 6% of the load. If it takes 2 min to fall through its full stroke , determine total work supplied and power delivered to the hydraulic appliance by the accumulator , when 8 lit / s of water is being delivered by a pump. The accumulator descends steadily. (8)

(c) Define Fluidics. Explain the working principle of a spool valve by citing an suitable example of your own. (5)

(d) Sketch and explain a logic state NAND gate with the help of a turbulence amplifier. (2)

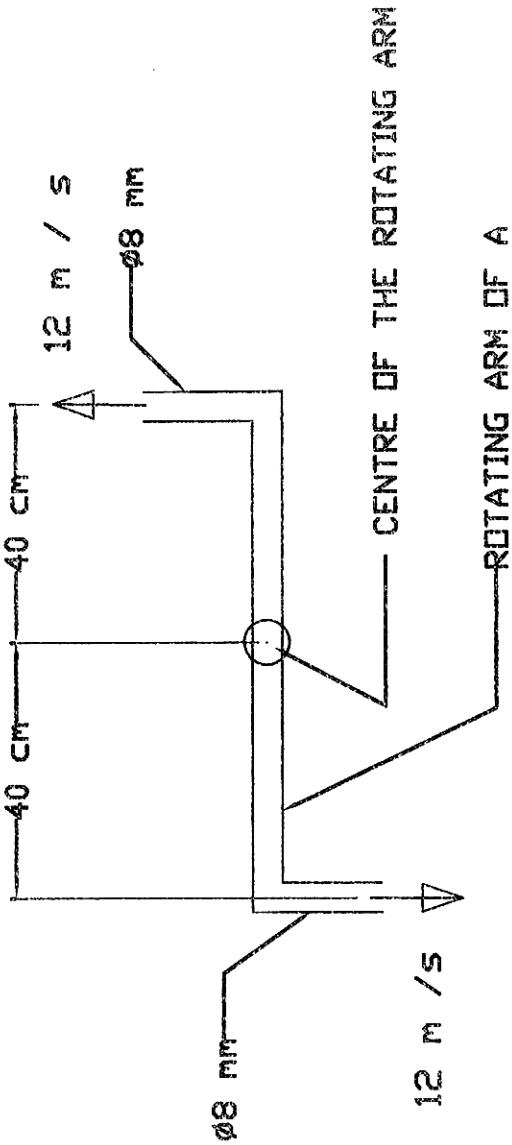
12 m / s
ø8 mm
40 cm
40 cm
CENTRE OF THE ROTATING ARM
ROTATING ARM OF A
LAWN SPRINKLER
ø8 mm
12 m /s

FIG 1