(3 hours) **Total marks: 80**

N.B.: (1) Question no.1 is compulsory.

(2) Attempt any 3 questions out of the remaining 5 questions.

(3) Assume data wherever necessary and clearly mention the assumptions made.

(4) Draw neat figures as required.

Q1 **Solve any four from the following** **20**

a Explain impulse momentum equation and its practical applications.
b What do you understand by scale effect in models?
c Describe briefly the functions of main components of Pelton wheel turbine with neat sketches.
d What do you mean by manometric efficiency, mechanical efficiency and overall efficiency of a centrifugal pump?
e Explain the working principle of hydraulic press.

Q2 a A lawn sprinkler has two nozzles of diameters 3 mm each is connected across a tap of water. The nozzles are at distance of 40 cm and 30 cm from the centre of the tap. The rate of flow of water through the tap is 100 cm^3/s. The nozzles discharge water in the downward directions. Determine the angular speed at which the sprinkler will rotate free. **10**

b. In a 45^0 reducing bend a rectangular air duct of 1 m^2 cross-sectional area is gradually reduced to 0.5 m^2 area. Find the magnitude and direction of the force required to hold the duct in position if the velocity of flow at the 1 m^2 section is 10 m/s, and pressure is 2.943 N/cm^2. Take density of air as 1.16 kg/m^3. **10**

Q3 a Derive on the basis of dimensional analysis suitable parameters to present the thrust developed by a propeller. Assume that the thrust P depends on the angular velocity ω, speed of advance V, diameter D, dynamic viscosity μ, mass density ρ, elasticity of the fluid medium which can be denoted by the speed of the sound in the medium C. **10**

b The ratio of lengths of a sub-marine and its model is 30:1. The speed of submarine (prototype) is 10 m/s. The model is to be tested in a wind tunnel. Find the speed of air in wind tunnel. Also determine the ratio of the drag (resistance) between the model and its prototype. Take the value of kinematic viscosities for sea-water and air as 0.012 stokes and 0.016 stokes respectively. The density for sea-water and air is given as 1030 kg/m^3 and 1.24 kg/m^3 respectively. **10**

Q4 a A jet propelled boat, moving with a velocity of 5 m/s, draws water amid-ship. The water is discharged through two jets provided at the back of the ship. The diameter of each jet is 150 mm. The total resistance offered to the motion of the boat is 4905 N. Determine (i) Volume of water drawn by the pump per second. (ii) Efficiency of the jet propulsion. **10**

b A jet of water having a velocity of 15 m/s strikes a curved vane, which is moving with a velocity of 5 m/s in the same direction as that of the jet at inlet. The vane is so shaped that the jet is deflected through 135 degrees. The diameter of jet is 100 mm. Assuming the vane to be smooth, find force exerted by the jet on the vane in the direction of motion, power exerted on the vane and efficiency of the vane. **10**

Q5 a A Pelton wheel is to be designed for the following specifications: **10**
Shaft power = 11,772 kW; Head =380 meters; Speed = 750 r.p.m.; Overall efficiency = 80%; Jet diameter not to exceed one sixth of the wheel diameter. Take K_{v1} = 0.985 and K_{u1} = 0.45.
Determine:
(i) The wheel diameter
(ii) The number of jets required
(iii) Diameter of the jet

b A turbine is to operate under a head of 25 m at 200 r.p.m. The discharge is 9 cumec. If the efficiency is 90%, determine the performance of the turbine under a head of 20 meters. **10**

Q6 a A three stage centrifugal pump has impeller 400 mm in diameter and 20 mm wide. The vane angle at outlet is 45^0 and the area occupied by the thickness of the vanes may be assumed 8 % of the total area. If the pump delivers 3.6 m^3 of water per minute when running at 920 r.p.m. determine: **10**
(i) Power of the pump,
(ii) Manometric head,and
(iii) Specific speed.
Assume mechanical efficiency as 88% and manometric efficiency as 77%.

b Write short notes on **10**
(i) Hydraulic ram
(ii) Hydraulic accumulator

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