B. Tech.

(SEM. VI) EVEN SEMESTER THEORY EXAMINATION, 2016-17

FLUID MACHINERY

Time : 3 Hours **Max. Marks : 100**

Note : Be precise in your answer. In case of numerical problem assume data wherever not provided.

Section-A

1. Attempt **all** parts of the following questions : (2 × 10 = 20)

a. **State and explain continuity equation of steady flow for incompressible fluids.**

Ans. Refer Q. 1.4, Page SQ–1A, 2 Marks Questions, Unit-1.

b. **Define degree of reaction.**

Ans. Refer Q. 2.7, Page SQ–5A, 2 Marks Questions, Unit-2.

c. **State the impulse momentum principle.**

Ans. Refer Q. 1.3, Page SQ–1A, 2 Marks Questions, Unit-3.

d. **What is the function of the nozzle in an impulse turbine ?**

Ans. Refer Q. 1.14, Page SQ–3A, 2 Marks Questions, Unit-1.

e. **What do you mean by radial flow turbine ?**

Ans. Refer Q. 2.3, Page SQ–4A, 2 Marks Questions, Unit-2.

f. **Define unit speed.**

Ans. Refer Q. 2.19, Page SQ–7A, 2 Marks Questions, Unit-2.

g. **What are the advantages of model testing ?**

Ans. Refer Q. 3.10, Page SQ–10A, 2 Marks Questions, Unit-3.

h. **Define manometric efficiency.**

Ans. Refer Q. 3.7, Page SQ–9A, 2 Marks Questions, Unit-3.

i. **What is the cause of acceleration head ?**

Ans. Refer Q. 4.12, Page SQ–12A, 2 Marks Questions, Unit-3.

j. **What is a hydraulic intensifier ?**

Ans. Refer Q. 5.2, Page SQ–14A, 2 Marks Questions, Unit-5.

Section-B

2. Attempt any **five** of the following questions : (10 × 5 = 50)

a. **Draw the neat sketch and explain the working of a simple accumulator.**

Ans. Refer Q. 5.1, Page 5–2A, Unit-5.

b. **Derive an expression for accelerating head in reciprocating pump assuming piston motion by SHM.**

Ans. Refer Q. 4.12, Page 4–13A, Unit-4.

c. **A centrifugal pump delivers 1.27 m^3 of water per minute at 1200 rpm. The impeller diameter is 350 mm and breadth at outlet 12.7 mm. The pressure difference between inlet and outlet of pump casing is 272 kN/m^2. Assuming manometric efficiency at 63 %, calculate the impeller exit blade angle.**

Ans. Refer Q. 3.12, Page 3–15A, Unit-3.

d. **Discuss performance characteristics of a hydraulic turbine.**

Ans. Refer Q. 2.27, Page 2–36A, Unit-2.

e. **Prove that a draft tube prevents for the loss of head of reaction turbine.**

Ans. Refer Q. 2.14, Page 2–20A, Unit-2.

f. **Explain the governing of a Pelton turbine. Use neat sketch.**

Ans. Refer Q. 1.26, Page 1–35A, Unit-1.

g. **A jet of water of diameter 50 mm having a velocity of 20 m/s strikes at inlet of a curved vane which is moving with a velocity of 10 m/s in the direction of the jet. The jet leaves the vane at an angle of 60° to the direction of motion of vane at outlet. Determine the force exerted by the jet on the vane in the direction of motion and work done per second by the jet.**

Ans. Refer Q. 1.8, Page 1–15A, Unit-1.

h. **Discuss the classification of hydraulic turbines.**

Ans. Refer Q. 1.13, Page 1–21A, Unit-1.

Section-C

Attempt any **two** of the following questions : (15 × 2 = 30)

3. **Explain with neat sketch the working of a hydraulic ram. Also, explain the various efficiencies applicable to hydraulic ram. State its advantages and limitations.**

Ans. Refer Q. 5.14, Page 5–20A, Unit-5.

4. **A single acting reciprocating pump running at 60 rpm has its piston area of 80 cm^2 and stroke length 150 mm. The area of suction pipe is 60 cm^2. The suction head is 3 m. Assuming a friction factor of 0.04, find the pressure head on the piston at the beginning, middle and at the end of the suction stroke if the length of suction pipe is 6 m. Assume motion of piston as SHM. Can cavitation takes place if the working liquid is water ?**

Ans. Refer Q. 4.18, Page 4–22A, Unit-4.

5. **A centrifugal pump running at 700 rpm is supplying 9 m^3/min of water against a head of 19.6 m. The blade angle at the blade exit is 135° with the direction of motion of the blade tip. Assume the entry of water at the inlet of vane is radial. The velocity of flow at inlet and outlet is constant at 1.8 m/s. Determine the necessary diameter and width of the impeller at exit allowing 8 % for vanes thickness and 40 % of energy corresponding to the velocity at exit from the impeller is recovered.**

Ans. Refer Q. 3.13, Page 3–16A, Unit-3.

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B. Tech.
(SEM. VI) EVEN SEMESTER THEORY EXAMINATION, 2017-18
FLUID MACHINERY

Time : 3 Hours **Max. Marks : 100**

Note : 1. Attempt all sections. If require any missing data; then choose suitable.

Section-A

1. Attempt all questions in brief. (2 × 10 = 20)

a. **What are fluid machines or hydraulic machines ?**

Ans. Refer Q. 1.1, Page SQ–1A, 2 Marks Questions, Unit-1.

b. **State the function of breaking jet in Pelton wheel turbine.**

Ans. Refer Q. 1.15, Page SQ–3A, 2 Marks Questions, Unit-1.

c. **Why spiral casing of varying area is employed in reaction turbine ?**

Ans. Refer Q. 2.9, Page SQ–5A, 2 Marks Questions, Unit-2.

d. **What is the function of draft tube ?**

Ans. Refer Q. 2.11, Page SQ–6A, 2 Marks Questions, Unit-2.

e. **What is meant by cavitation with reference to reaction turbine ?**

Ans. Refer Q. 2.13, Page SQ–6A, 2 Marks Questions, Unit-2.

f. **Differentiate between volute and vortex casing of a centrifugal pump.**

Ans. Refer Q. 3.3, Page SQ–8A, 2 Marks Questions, Unit-3.

g. **What is meant by manometric head for centrifugal pump ?**

Ans. Refer Q. 3.5, Page SQ–9A, 2 Marks Questions, Unit-3.

h. **What is NPSH ?**

Ans. Refer Q. 3.13, Page SQ–10A, 2 Marks Questions, Unit-3.

i. **What is meant by positive displacement pump ?**

Ans. Refer Q. 4.1, Page SQ–11A, 2 Marks Questions, Unit-4.

j. **Define the term slip of reciprocating pump.**

Ans. Refer Q. 4.8, Page SQ–12A, 2 Marks Questions, Unit-4.

Section-B

2. Attempt any three of the following : (10 × 3 = 30)

a. **Derive moment of momentum equation. Also explain its significance.**

Ans. Refer Q. 1.3, Page 1–3A, Unit-1.

b. **Discuss the characteristics curves of hydraulic turbines in details.**

Ans. Refer Q. 2.27, Page 2–36A, Unit-2.

c. **A Kaplan turbine develops 9000 kW under a net head of 7.5 m. Overall efficieny of the turbine is 86 %. The speed ratio based on the outer diameter is 2.2 and the flow ratio is 0.66. Diameter of the boss is 0.35 times the external diameter of the wheel. Determine the diameter of runner and the specific speed of the runner.**

Ans. Refer Q. 2.22, Page 2–31A, Unit-2.

d. **A centrifugal pump discharges 5 m³/s under a head of 130 m running at 600 rpm. Outer diameter of impeller is 2 m and has a positive suction lift of 3.2 m including velocity head and friction losses in suction pipe. Experiments were conducted on a geometrically similar model of 0.4 m outer diameter of impeller under a head of 90 m. Vapour pressure of liquid is equal to 0.35 m of head. Calculate the discharge, speed and suction lift for the model. Assume atmospheric pressure head = 10.2 m of water.**

Ans. Refer Q. 3.21, Page 3–24A, Unit-3.

e. **With a neat sketch, write down short notes on air lift pump.**

Ans. Refer Q. 5.20, Page 5–28A, Unit-5.

Section-C

3. Attempt any one of the following : (10 × 1 = 10)

a. **A 7.5 cm diameter jet having a velocity of 30 m/s strikes a flat plate, the normal of which inclined at 45° to the axis of the jet. Find the normal pressure on the plate ;**

i. **When the plate is stationary, and**

ii. **When the plate is moving with a velocity of 15 m/s and away from the jet. Also determine the power and efficiency of the jet when the plate is moving.**

Ans. Refer Q. 1.7, Page 1–14A, Unit-1.

b. **What do you understand by term governing of turbine ? Explain governing mechanism forPelton wheel.**

Ans. Refer Q. 1.26, Page 1–35A, Unit-1.

4. Attempt any one of the following : (10 × 1 = 10)

a. **Discuss the various characteristic curves of hydraulic turbines in detail.**

Ans. Refer Q. 2.27, Page 2–36A, Unit-2.

b. **A reaction turbine is revolving at a speed of 200 rpm and develops 5886 kW SP when working under a head of 200 m with an overall efficiency of 80 %. Determine unit speed, unit discharge and unit power. The speed ratio for the turbine is given as 0.48. Find the speed, discharge and power when this turbine is working under a head of 150 m.**

Ans. Refer Q. 2.26, Page 2–35A, Unit-2.

5. Attempt any one of the following : (10 × 1 = 10)

a. **Classify hydraulic turbines in detail.**

Ans. Refer Q. 1.13, Page 1–21A, Unit-1.

b. **Determine the overall efficiency of a Kaplan turbine developing 2850 kW under a head of 5.2 m. It is provided with a draft tube with its inlet (diameter 3 m) set 1.8 m above the tail race level. A vacuum gauge connected to the draft tube indicates a reading of 5.2 m of water. Assume draft tube efficiency as 75 %.**

Ans. Refer Q. 2.15, Page 2–21A, Unit-2.

6. Attempt any one of the following : (10 × 1 = 10)

a. **A centrifugal pump with 1.2 m diameter runs at 200 rpm and discharges 1900 liters water per second, the average lift being 6 m. The angle which the vanes make at exit with the tangent to the impeller is 26° and the radial velocity of flow is 2.5 m/s. The inner diameter of the impeller is 0.6 m. Determine :**
The power required to drive the pump, the manometric efficiency and the minimum rpm to start pumping against a head of 6 m.

Ans. Refer Q. 3.15, Page 3–18A, Unit-3.

b. **What is priming in centrifugal pump ? Why it is done ? What is self-priming pump ? Explain.**

Ans. Refer Q. 3.18, Page 3–22A, Unit-3.

7. Attempt any one of the following : (10 × 1 = 10)

a. **What do you understand by an indicator diagram ? Explain ideal indicator diagram.**

Ans. Refer Q. 4.10, Page 4–11A, Unit-4.

b. **A single acting reciprocating pump of 12 cm diameter and 24 cm stroke is delivering water to the tank which is 10 m above the center of pump. The pump is located 5 m above the center of sump. The diameter and the length of the suction pipe are 5 cm and 5 m respectively, and diameter and length of delivery pipe are 4 cm and 20 m respectively. Find the maximum speed of the pump to avoid separation either in suction pipe or delivery pipe. Take atmospheric pressure head 10.33 m of water and separation occurs at 80 kN/m^2 below atmospheric pressure.**

Ans. Refer Q. 4.17, Page 4–21A, Unit-4.

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B. Tech.

(SEM. VI) EVEN SEMESTER THEORY EXAMINATION, 2018-19

FLUID MACHINERY

Time : 3 Hours **Max. Marks : 70**

Note : 1. Attempt all sections. If require any missing data; then choose suitably.

Section-A

1. Attempt **all** questions in brief. (2 × 7 = 14)

a. **What is the difference between fluid mechanics and fluid machinery ?**

Ans.

S. No.	Fluid Mechanics	Fluid Machinery
1.	It is that branch of engineering science which deals with the behaviour of fluid under the condition of rest or motion.	It is that branch of fluid mechanics which deals with the study of machines operating on fluid.

b. **Why are turbines more efficient than pumps ?**

Ans. During deceleration, the boundary layer increases in thickness and can also stop the system. Therefore, there are losses in case of pumps. Hence, pumps are less efficient than turbines due to huge losses in pumps.

c. **What is whirl velocity in a turbine ? Give the significance of whirl velocity.**

Ans. **Whirl Velocity :** The whirl velocity is the tangential component of absolute velocity at the blade inlet and outlet.

Significance : Component of whirl velocity is responsible for the whirling or rotating of the turbine rotor.

d. **Why do impulse turbine need high head and low flow rate and the reverse is needed for reaction turbine ?**

Ans. Impulse turbine need high head and low flow rate because impulse turbine posses only kinetic energy at its inlet while reaction turbine posses both kinetic as well as pressure energy, therefore it need low head and high flow rate.

e. **What is NPSH ? Why do we need to calculate NPSH ?**

Ans. **NPSH :** Refer Q. 3.13, 2 Marks Questions, Page 3–10A, Unit-3.

Necessity of Calculation of NPSH : We need to calculate NPSH because a minimum amount of suction pressure head is needed for a pump to operate without cavitating.

f. Why the reciprocating pump is called positive displacement pump ?

Ans. Reciprocating pumps are called as positive displacement pumps since they discharge a fixed amount of fluid in every stroke.

g. Why do we use an accumulator in a hydraulic system ?

Ans. An accumulator enables a hydraulic system to cope up with extremes of demand using a less powerful pump to respond more quickly to a temporary demand, and to smoothen out pulsations.

Section-B

2. Attempt any **three** of the following : **(7 × 3 = 21)**

a. A jet of water having velocity of 11.5 m/s impinges a vane, which is moving with a velocity of 4.5 m/s. The vane is so shaped that the jet is deflected through 115°. Find the angle of the jet so that there is no shock at inlet. What is the absolute velocity of the jet at exit in magnitude and direction and the work done per second per unit weight of striking per second ? Assume that the vane is smooth.

Ans. Same as Q. 1.9, Page 1–16A, Unit-1.

(**Answer :** i. Angle of jet = 20.37°

ii. Absolute velocity of jet at exit = 4.37 m/s

iii. Work done per second = 5.76 Nm/s per unit weight)

b. Show that the hydraulic efficiency for a Francis turbine having velocity of flow through runner as constant, is given by the relation :

$$\eta_h = \frac{1}{1 + \dfrac{\frac{1}{2}\tan^2\alpha}{1 - \left(\dfrac{\tan\alpha}{\tan\theta}\right)}}$$

Where α = The guide blades angle and θ = Vane angle of the runner and there is no friction on the blades.

The turbine is having radial discharge at outlet. If the vanes are radial at inlet, then show that,

$$\eta_h = \frac{2}{2 + \tan^2\alpha}$$

Ans. Refer Q. 2.10, Page 2–13A, Unit-2.

c. Why are centrifugal pumps used sometimes in series and sometimes in parallel ? Give the operational difficulties commonly experienced in centrifugal pumps and their remedies.

Ans.

A. Reason for Using Centrifugal Pumps Sometimes in Series and Sometimes in Parallel : When we require high heads then connect pump in series and when we require high discharge then connect pump in parallel.

B. Operational Difficulties in Centrifugal Pumps :

1. Pump fails to start pumping.
2. Pump is not working upto capacity and pressure.

3. Pump stops working.
4. Pump has very low efficiency.

C. **Remedies :**
1. Reduce motor speed.
2. Install an impeller inducer.
3. Incorporate a booster pump into pump system.
4. Increase liquid level around the suction area.

d. What is the effect of acceleration of piston on velocity and pressure in the suction and delivery pipe of reciprocating pump ? Obtain an expression for the pressure head due to acceleration in the suction and delivery pipes.

Ans.
A. **Effect of Acceleration in Suction and Delivery Pipe of Reciprocating Pump :** Refer Q. 4.13, Page 4–15A, Unit-4.

B. **Expression for the Pressure Head Due to Acceleration in the Suction and Delivery Pipes :** Refer Q. 4.12, Page 4–13A, Unit-4.

e. What is function of torque converter ? Describe with the help of a neat sketch its constructional features and working. Discuss its characteristics. State its merits, limitations and applications.

Ans.
A. **Function of Torque Converter :** Refer Q. 5.19, Page 5–26A, Unit-5.

B. **Constructional Features and Working :** Refer Q. 5.19, Page 5–26A, Unit-5.

C. **Characteristics :** The main characteristic of a torque converter is its ability to multiply torque when the output rotational speed is so low.

D. **Merits :**
1. It produces the maximum torque as compared with the vehicle equipped with clutch.
2. It removes the clutch pedal.
3. It makes the job of driving a vehicle easier.

E. **Limitations :**
1. Its fuel efficiency is low as compared with the vehicle with manual transmission.
2. The torque available to start the vehicle from rest in first gear reduces with the increase in speed of the vehicle.
3. There is no torque multiplication in third and fourth gear.

F. **Applications :**
1. The torque converter is used in the vehicle that is equipped with the automatic transmission.
2. It is also used in industrial power transmission such as conveyer drives, drilling rigs, almost all modern forklifts, construction equipment, and railway locomotives.
3. It is used in marine propulsion systems.

Section-C

3. Attempt any **one** of the following : **(7 × 1 = 7)**

a. What do you understand by the term jet of water ? Develop an expression for the efficiency of a series of moving curved plates ... of the tips.

Ans.

A. **Jet of Water :** A jet of water is a stream of water that is projected into a surrounding medium, usually from some kind of a nozzle, aperture or orifice.

B. **Expression :** Refer Q. 1.6, Page 10A, Unit-1.

b. **Explain why a notch is made in tips of Pelton turbine buckets. A pelton wheel is working under a head of 550 m and produces 10000 kW at 450 rpm. If the efficiency of the wheel is 85 %, determine the discharge of the turbine, diameter of the wheel and diameter of nozzle (assume coefficient of velocity as 0.98 and speed ratio as 0.45).**

Ans.

A. **Reason of Making a Notch in Tips of Pelton Turbine Buckets :** Notch is made in tips of pelton turbine buckets in order to allow the water jet to flow into each bucket at an optimum angle.

B. **Numerical :**

Given : $H = 550$ m, $P = 10000$ kW, $N = 450$ rpm, $\eta = 85$ %, $C_v = 0.98$, $\phi = 0.45$.
To Find : i. Discharge of the turbine.
ii. Diameter of wheel.
iiii. Diameter of nozzle.

1. Velocity of jet at inlet,

$$v_1 = C_v\sqrt{2gH} = 0.98 \times \sqrt{2 \times 9.81 \times 550} = 101.80 \text{ m/s}$$

2. Velocity of wheel, $u = \phi\sqrt{2gH} = 0.45\sqrt{2 \times 9.81 \times 550} = 46.74$ m/s

3. Wheel diameter, $D = \dfrac{60\,u}{\pi N} = \dfrac{60 \times 46.74}{\pi \times 450} = 1.98$ m

4. Overall efficiency, $\eta_o = P / \rho QgH$

$$0.85 = \frac{10000 \times 10^3}{1000 \times Q \times 9.81 \times 550}$$

$$Q = 0.216 \text{ m}^3/\text{s}$$

5. We know that, $Q = \dfrac{\pi}{4} d^2\, v_1$

$$d^2 = \frac{4Q}{\pi v_1} = \frac{4 \times 0.216}{\pi \times 101.80} = 0.002 \text{ m}$$

$\therefore$ Diameter of nozzle, $d = 0.0519$ m $= 51.9$ mm

4. Attempt any one of the following : (7 × 1 = 7)

a. **What is cavitation ? How does it affect the performance of hydraulic machines ? How can it be avoided in reaction turbines ? Define Thoma's cavitation number.**

Ans. Refer Q. 2.16, Page 2–22A, Unit-2.

b. **An inward flow reaction turbine works under an average head of 160 m with a discharge of 80 m³/s. The inlet and outlet diameters of the turbine are 4 m and 2 m, respectively. The runner blade**

angle at the inlet is 120°. Radial discharge velocity at the outlet is 15 m/s. Assuming constant breadth of wheel and 90 % hydraulic efficiency, determine the HP produced in megawatt and the revolution per minute of the machine.

Ans.

Given : $H = 160$ m, $Q = 80$ m^3/s, $D_1 = 4$ m, $D_2 = 2$ m, $\theta = 120°$, $u_2 = 15$ m/s, $\eta_h = 90$ %, $B_1 = B_2$

To Find : i. HP produced in mega watt.
ii. Revolution per minute of the machine.

1. Hydraulic efficiency is given by, $\eta_h = V_{w1} u_1 / gH$

$$0.90 = V_{w1} u_1 / 9.81 \times 160$$
$$V_{w1} u_1 = 1412.64$$

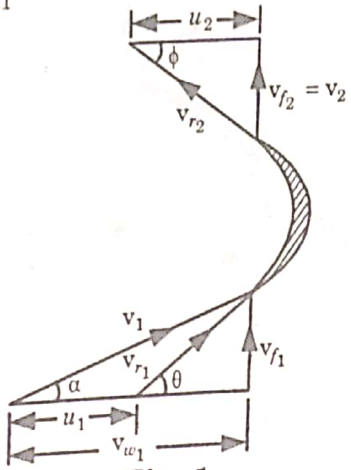

Fig. 1.

2. Power produced (in MW)

$$= \frac{\text{Work done per second}}{1000} = \frac{\rho Q[V_{w_1} u_1]}{1000} = \frac{1000 \times 80 \times [1412.64]}{1000}$$

$= 113011.2$ W $= 0.1130$ MW

3. We know, $u_2 = \pi D_2 N / 60$

∴ $N = 60 \times 15 / \pi \times 2 = 143.2$ rpm

4. Revolution per minute of the machine (N) = 143.2 rpm

5. Attempt any one of the following : **(7 × 1 = 7)**

a. **Explain why priming is necessary to start pumping by centrifugal pump. Briefly explain the significance of similarity parameters in centrifugal pump.**

Ans.

A. **Priming and its Necessity :** Refer Q. 3.18, Page 3–22A, Unit-3.

B. **Significance of Similarity Parameters in Centrifugal Pumps :** Refer Q. 2.17, Page 2–24A, Unit-2.

b. **A centrifugal pump has an impeller of 0.5 m outer diameter and when running at 600 rpm, it discharges at the rate of 8000 *l*/m against a head of 8.5 m. The water enters the impeller without whirl and shock. The inner diameter is 0.25 m and the vanes are set back at outlet at an angle of 45° and the area of flow which is constant from inlet to outlet of the impeller is 0.06 m². Determine the**

i. **Manometric efficiency of the pump.**
ii. **Vane angle at inlet.**
iii. **Least speed at which the pump commences to work.**

Ans.

Given : $D_2 = 0.5$ m, $N = 600$ rpm, $Q = 8000$ l/m $= 0.133$ m^3/s, $H_m = 8.5$ m, $D_1 = 0.25$ m, $\phi = 45°$, $A = 0.06$ m^2

1. We know that, $u_1 = \dfrac{\pi D_1 N}{60} = \dfrac{\pi \times 0.25 \times 600}{60} = 7.854$ m/s

Also, $u_2 = \dfrac{\pi D_2 N}{60} = \dfrac{\pi \times 0.5 \times 600}{60} = 15.70$ m/s

2. Discharge $Q = A \times v_{f1}$

$0.133 = 0.06 \times v_{f1}$

$v_{f1} = 2.222$ m/s $= v_{f2}$

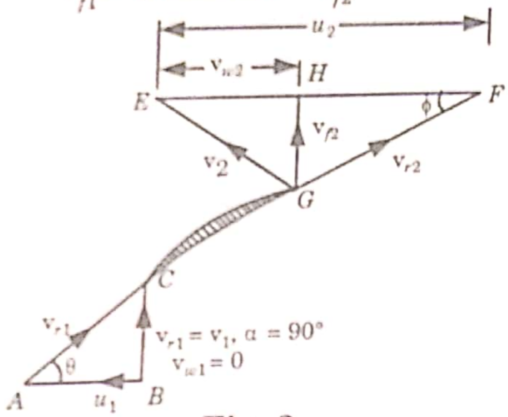

Fig. 2.

3. From ΔABC $\quad \theta = \tan^{-1}\left(\dfrac{v_{f1}}{u_1}\right) = \tan^{-1}\left(\dfrac{2.222}{7.854}\right) = 15.79°$

4. From ΔEGF, $EH = EF - HF$

$v_{w2} = u_2 - \dfrac{v_{f2}}{\tan\phi} = 15.70 - \dfrac{2.222}{\tan 45°} = 15.70 - 2.222 = 13.48$ m/s

5. Manometric efficiency, $\eta_m = \dfrac{gH_m}{v_{w_2} u_2} = \dfrac{9.81 \times 8.5}{13.48 \times 15.70} = 0.39 = 39\ \%$

6. Least speed of pump,

$N_{min} = \dfrac{120 \times \eta_m\, v_{w2}\, D_2}{\pi(D_2^2 - D_1^2)} = \dfrac{120 \times 0.39 \times 13.48 \times 0.5}{\pi[(0.5)^2 - (0.25)^2]} = 535.4$ rpm

6. Attempt any **one** of the following : (7 × 1 = 7)

a. **Show that work saved in overcoming friction in pipelines by fitting air vessels in a reciprocating pump is 39.2 % for double acting pump.**

Ans. Refer Q. 4.22, Page 4–28, Unit-4.

b. **A double acting pump runs at 85 double strokes per minute in a harmonic motion. This pump's piston has a diameter of 0.120 m and stroke of 0.220 m. If the pump has a vertical suction pipe which is 5 m long and 110 mm in diameter,**

then compute the maximum permissible suction lift, assuming that separation occurs at 2 m of absolute. Use atmospheric head of water as 10.3 m.

Ans.

Given : N = 85 double strokes per minute, D = 0.120 m, l = 0.220 m, l_s = 5 m, d_s = 110 mm = 0.11 m, Separation occurs = 2 m of absolute, Atmospheric head of water = 10.3 m

To Find : Maximum permissible suction lift.

1. Area of suction pipe, $a_s = \frac{\pi}{4} d_s^2 = \frac{\pi}{4} \times (0.11)^2 = 0.0095 \text{ m}^2$
2. Area of pump piston, $A = \frac{\pi}{4} d^2 = \frac{\pi}{4} \times (0.120)^2 = 0.011 \text{ m}^2$
3. We know that, $h_{as} = H_{atm} - h_s - h_{sep}$ ...(1)
4. We also know that, $h_{as} = \frac{l_s}{g} \frac{A}{a_s} \omega^2 r$ ...(2)
5. By equating eq. (1) and eq. (2) we get

$$H_{atm} - h_s - h_{sep} = \frac{l_s}{g} \frac{A}{a_s} \omega^2 r, \; H_{atm} - h_{sep} - \frac{l_s}{g} \frac{A}{a_s} \omega^2 r = h_s$$

$$10.3 - 2 - \frac{5}{9.81} \times \frac{0.011}{0.0095} \times 0.11\, \omega^2 = h_s \quad \left(\because \omega = \frac{2\pi N}{60} = \frac{2\pi \times 170}{60} = 17.80 \right)$$

$$10.3 - 2 - \frac{5}{9.81} \times \frac{0.011}{0.0095} \times 0.11 \times (17.80)^2 = h_s$$

$\therefore$ Suction lift, h_s = – 12.26 m

7. Attempt any one of the following : (7 × 1 = 7)

a. **What is function of hydraulic press? Describe with the help of a neat sketch its constructional features and working. Discuss its characteristics. State its merits, limitations and applications.**

Ans.

A. **Function of Hydraulic Press :** Refer Q. 5.7, Page 5–9A, Unit-5.

B. **Constructional Features and Working of Hydraulic Press :** Refer Q. 5.7, Page 5–9A, Unit-5.

C. **Characteristics :**

1. Variable stroke length.
2. Slide motion and position control throughout the range of the stroke length.
3. Full working energy at any speed.
4. Full press capacity at any point in the stroke.

D. **Merits :**

1. Built-in overload protection.
2. It is safe compared to mechanical press.
3. It is compact.
4. Lower tool cost due to built-in overload protection.

E. Limitations :

1. Handling of hydraulic oil can be messy.
2. Hydraulic lines could burst due to excess pressure.
3. Some hydraulic fluids can catch fire.
4. There are chances of hydraulic fluid leakage.

F. Applications :

1. Aerospace industry. 2. Automotive parts.
3. Thermoplastic industries.

b. An accumulator is loaded with 400 kN weight. The ram has a diameter of 300 mm and stroke of 6 m. Its friction may be taken as 5 %. It takes 2 minute to fall through its full stroke. Find the total work supplied and power delivered to the hydraulic appliance by the accumulator, when 0.0075 m³/s of liquid is being delivered by a pump, while the accumulator descends with stated velocity.

Ans.

Given : $W = 400$ kN, $D = 300$ mm $= 0.3$ m, $A = \frac{\pi}{4} \times 0.3^2 = 0.07068$ m^2, $l = 6$ m, Friction $= 5$ %, $Q = 0.0075$ m^3/s

To Find : Total work supplied and power delivered.

1. Net load on accumulator when it descends $= 400 \times 0.95 = 380$ kN
2. Time taken by ram to fall through full stroke, $t = 2$ min or 120 s

$\therefore$ Distance moved by ram per sec $= \frac{l}{t} = \frac{6}{120} = 0.05$ m/s

3. Work done by accumulator per second
$=$ Net load on ram $\times$ Distance moved by ram per sec
$= 380 \times 0.05 = 19$ kNm/s

4. Intensity of pressure of water, $p = \frac{\text{Net load}}{\text{Area}} = \frac{380 \times 10^3}{0.07068}$
$= 5376.3 \times 10^3$ N/m^2

5. Pressure head, $H = \frac{p}{\rho g} = \frac{5376.3 \times 10^3}{9810} = 548$ m

6. Work supplied by pump per second = Weight of water supplied per sec $\times$ Pressure head
$= \rho g Q H = 9810 \times 0.0075 \times 548$
$= 40319$ Nm/s $= 40.319$ kNm/s

7. Total work supplied to hydraulic machine
= Work supplied by accumulator + Work supplied by the pump
$= 19 + 40.319 = 59.319$ kNm/s

$\therefore$ Power delivered to the hydraulic machine = 59.319 kW

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