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## ***B.Tech. Degree IV Semester Regular/Supplementary Examination in Marine Engineering June 2022***

**19-208-0405 HYDRAULIC MACHINERY**  
(2019 Scheme)

Time: 3 Hours

Maximum Marks: 60

Course Outcome

On successful completion of the course, the students will be able to:

CO1: Understand dimensional analysis and principles of similitude.

CO2: Apply the momentum principles to impinging jets and analyse the performance of hydraulic turbine.

CO3: Learn the performance characteristics of various hydraulic turbines, their specific speed and speed control.

CO4: Understand the working of roto-dynamic pumps and positive displacement pumps.

CO5: Study the principle of working of hydraulic devices.

Bloom's Taxonomy Levels (BL): L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

PO – Programme Outcomes.

**PART A**(Answer *ALL* questions)

(5 × 15 = 75)

		Marks	BL	CO	PO
I.	(a) Describe geometric, kinematic and dynamic similarities.	5	L1	1	1.2.1
	(b) The pressure drop in an aeroplane model of size 1/10 of its prototype is 80 N/cm <sup>2</sup> . The model is tested in water. Calculate the corresponding pressure drop in the prototype. Take density of air as 1.24 kg/m <sup>3</sup> . The viscosity of water and air as 0.01 poise and 0.00018 poise respectively.	10	L3	1	2.1.2
<b>OR</b>					
II.	(a) State Buckingham's $\pi$ -theorem.	5	L1	1	1.2.1
	(b) Using Buckingham's $\pi$ theorem, derive an equation for pressure difference inside a pipe. The pressure difference in a pipe of diameter 'D' and length 'l' due to turbulent flow depends on the velocity 'V', viscosity ' $\mu$ ', density ' $\rho$ ' and roughness ' $k$ '.	10	L3	1	2.1.2
III.	(a) Derive the equation of force exerted by a jet on moving inclined plate.	5	L2	2	1.2.1
	(b) A jet of water of diameter 7.5 cm strikes a curved plate at its centre with a velocity of 20 m/s. The curved plate is moving with a velocity of 8 m/s in the direction of the jet. The jet is deflected through an angle of 165°. Assuming the plate smooth find: (i) Force exerted on the plate in the direction of jet (ii) Power of the jet (iii) Efficiency of the jet.	10	L3	2	2.1.2
<b>OR</b>					
IV.	(a) Explain the classification of turbines.	5	L2	2	1.2.1
	(b) A Kaplan turbine runner is to be designed to develop 7357.5 kW shaft power. The net available head is 5.50 m. Assume that the speed ratio is 2.09 and flow ratio is 0.68, and the overall efficiency is 60%. The diameter of the boss is 1/3rd of the diameter of the runner. Find the diameter of the runner, its speed and its specific speed.	10	L3	2	2.1.2

(P.T.O.)

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- V. A Francis turbine with an overall efficiency of 75% is required to produce 148.25 kW power. It is working under a head of 7.62 m. The speed ratio and flow ratio at inlet are 0.26 and 0.96 respectively. The wheel runs at 150 r.p.m. and the hydraulic losses in the turbine are 22% of the available energy. Assuming radial discharge, determine:
- The guide blade angle
  - The wheel vane angle at inlet
  - Diameter of the wheel at inlet
  - Width of the wheel at inlet.
- OR
- VI. The following data is given for a Francis Turbine. Net head  $H = 60$  m; Speed  $N = 700$  r.p.m.; shaft power = 294.3 kW; Overall efficiency = 84%; Hydraulic efficiency = 93%; flow ratio = 0.20; breadth ratio = 0.1; Outer diameter of the runner = 2 x inner diameter of runner. The thickness of vanes occupy 5% of circumferential area of the runner, velocity of flow is constant at inlet and outlet and discharge is radial at outlet. Determine:
- Guide blade angle
  - Runner vane angles at inlet and outlet
  - Width of the wheels
  - Diameters of runner at inlet and outlet.
- VII. The diameter and stroke length of a single-acting reciprocating pump are 100 mm and 300 mm respectively. The water is lifted to a height of 20 m above the centre of the pump. Separation occurs if the absolute pressure head in the cylinder during delivery stroke falls below 2.50 m of water. Take atmospheric pressure head = 10.3 m of water. Find the maximum speed at which the pump may be run so that no separation occurs during the delivery stroke if the diameter and length of pipe are 50 mm and 25 m respectively.
- OR
- VIII. The internal and external diameter of an impeller of a centrifugal pump which is running at 1000 r.p.m., are 200 mm and 400 mm respectively. The discharge through pump is  $0.04 \text{ m}^3/\text{s}$  and velocity of flow is constant and equal to 2.0 m/s. The diameters of the suction and delivery pipes are 150 mm and 100 mm respectively and suction and delivery heads are 6 m (abs.) and 30 m (abs.) of water respectively. If the outlet vane angle is  $45^\circ$  and power required to drive the pump is 16.186 kW, determine:
- Vane angle of the impeller at inlet
  - The overall efficiency of the pump.

(Continued)

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|---------|---|----|----|---|-------|
| IX. (a) | Explain the working of hydraulic accumulator with the help of a neat figure.  | 5  | L2 | 5 | 1.2.1 |
| (b)     | An accumulator has a ram of diameter 0.25 m and a lift of 8 m. The total weight on accumulator is 0.07 MN. The packing friction is 5% of the load on the ram. Calculate the power delivered to the machine if ram falls through the full height in 100 sec and at the same time the pumps are delivering 0.028 m <sup>3</sup> /s through the accumulator. | 10 | L3 | 5 | 2.1.2 |

OR

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|--------|--|----|----|---|-------|
| X. (a) | Explain the working of hydraulic crane with the help of a neat figure.   | 5  | L2 | 5 | 1.2.1 |
| (b)    | The efficiency of a hydraulic crane, which is supplied with water under a pressure of 70 N/cm <sup>2</sup> for lifting a weight through a height of 10 m, is 60%. If the diameter of the ram is 150 mm and velocity ratio is 6, calculate the weight lifted by the crane, and the volume of water required in litres to lift the weight. | 10 | L3 | 5 | 2.1.2 |

Blooms's Taxonomy Levels

L1 - 6.6%, L2 - 13.3%, L3 - 40%, L4 - 40%.

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