B.E. MECHANICAL ENGINEERING THIRD YEAR FIRST SEMESTER EXAM 2024

Ref. No. : Ex/ME(M2)/PC/B/T/311/2024

FLUID MACHINERY- II

Time:-Three Hours Full Marks:-100

Answer any **five** Questions

Assume any data relevant to the questions if not provided

1. Explain Buckingham π-theorem. By using the dimensional analysis for the incompressible flow through the turbo-machinery find the flow, head and power coefficients respectively. Explain why they are so important. (20)

2. a) With a neat diagram explain the main components of an axial flow Compressor and briefly explain the function of them. (10)

   b) The mean bucket speed of a Pelton wheel turbine is 12 m/s and the rate of flow of water supplied by the jet under a head of 46 m is 850 litres per second. If the jet is deflected by the bucket at an angle of 165°, then find the power and efficiency of the turbine. Assume the coefficient of velocity as 0.985. (10)

3. a) What do you understand by Multistaging of Centrifugal pumps? Explain with neat diagram the following: Centrifugal Pumps in
   (1) Parallel connection
   (2) Series connection. (12)

b) A centrifugal pump is to discharge 0.118 m^3/s at a speed of 1450 r. p. m. against a head of 25 m. The impeller diameter is 250 mm, its width at outlet is 50 mm and manometric efficiency is 75%. Determine the vane angle at the outer periphery of the impeller. (08)

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4. a) Draw the characteristics curves (H *vs* Q, P_{in} *vs* Q *and* η *vs* Q) in connection with a centrifugal pump. (5)

b) Two Centrifugal Pumps A and B are available for use in a pipe flow system having their characteristics as given below:

Pump A		Pump B	
Discharge Q (m^3/s)	Head H (m)	Discharge Q (m^3/s)	Head H (m)
0	38.0	0	45.00
0.13	34.50	0.14	42.50
0.15	30.00	0.23	35.50
0.22	20.00	0.32	27.85
0.32	15.00	0.40	17.05

Determine the head-capacity curves when these pumps are in parallel connection using graph paper. (15)

5. a) Explain analytically and graphically the ideal change in total head of an axial turbomachine indicating the zones of operation of a pump and a turbine. (10)

b) The guide blade angle at inlet of a Francis turbine is 20°. Assuming radial vanes at both inlet and outlet and flow velocity remains constant, determine the hydraulic efficiency. (10)

6. a) What do you mean by "degree of reaction" of a reaction turbine? Obtain an expression for it in terms of the moving and fixed blade angles. (10)

b) A centrifugal pump with backward curved blades is operating at 800 RPM and has diameter at outlet of 30 cm. The velocity of flow is constant at 2 m/s. Determine the ratio of pressure head to velocity head produced by the impeller. Deduce any equation you use. (10)

7. The experimental data for the performance test of a double entry Centrifugal Pump is as given below:

Run No.	1	2	3	4	5	6
Test Speed (in r.p.m.)	1500	1520	1540	1560	1580	1600
Discharge (Lit./min.)	681	665	640	580	440	0
Suction Gauge Reading (in m of water)	4.00	3.80	3.40	3.25	0.700	0.400
Delivery Gauge Reading (in m of water)	28.0	22.0	20.1	17	22	24.0
Power input to the pump (in KW)	4.82	4.62	3.83	2.9	2.72	2.0

The suction and delivery pipes attached to the pump are of same diameter and the centers of the suction and delivery gauges are located on the same horizontal plane. Plot the following curves using the above test-data at a rated speed of 1560 r.p.m.

i) Total Head (H) Vs. Discharge (Q)
ii) Pump input Power (P) Vs. Discharge (Q)
iii) Overall Efficiency (η_o) Vs. Discharge (Q).

Find from these curves the rated head, rated discharge and rated power input of the pump using graph paper. (20)

8. a) A Kaplan turbine develops 50000 kW of power under a net head of 30 m with an overall efficiency of 85%. The speed ratio of the Kaplan Turbine is 2.0 and the flow ratio is 6.0 respectively. The diameter of the boss of the turbine is 0.35 times the diameter of the runner. Draw the velocity diagrams of the Kaplan Turbine and calculate the diameter, speed and specific speeds (Both dimensional and non-dimensional) of the turbine. (10)

b) A reaction turbine works at 450 r. p. m. under a head of 120 m. Its diameter at the inlet is 1.2 m and the flow area is 0.4 m^2. The angles made by absolute and relative velocities at the inlet are 20° and 60° respectively with the tangential velocity. If the velocity of whirl at the outlet is zero determine 1) volume flow rate ii) power developed and iii) hydraulic efficiency. (10)

9. Write short notes on the following:

a) Cavitation b) NPSH available and NPSH required c) Penstock d) Draft Tube.(5 X 4 =20)