B.E. MECHANICAL ENGINEERING
THIRD YEAR FIRST SEMESTER EXAM 2025
FLUID MACHINERY-II
Ref. No. : ME(M2)/PC/B/T/311

Time:-Three Hours Full Marks:-100

Answer any **five** Questions

Assume any data relevant to the questions if not provided

1. What is Buckingham π-theorem. Using dimensional analysis in connection with a turbo-machine obtain the non-dimensional functional relationship between the variables of an incompressible turbo-machinery. (20)

2. a) What do you understand by geometrically similar turbo machines? What are the dimensional and non-dimensional "Specific Speed" and "unit quantities" of an incompressible-flow Turbo-machine? (12)

b) Two geometrically similar pumps are running at the same speed of 1000 r. p. m. One pump has an impeller diameter 300 mm and lifts water at the rate of 0.02 m^3/s against a head of 15 m. Determine the head and impeller diameter of the other pump to deliver half the discharge. (08)

3. a) Define and find unit quantities in connection with turbo-machinery. Why they are so important? (08)

b) A Hydraulic turbine is rotating at a speed of 1100 r. p. m. and develops 5000 KW, working under a head of 470 m with an overall efficiency of 86 %. Determine "Unit Speed", "Unit Discharge" and "Unit Power" and the dimensional and non-dimensional specific speed of the Turbine. (12)

4. The experimental data for the performance test of a single-entry Centrifugal Pump is as given below:

Run No.	1	2	3	4	5	6
Test Speed (in r.p.m.)	1400	1420	1440	1460	1480	1500
Discharge (Lit./min.)	3000	2400	1800	1200	600	0
Suction Gauge Reading (in m of water)	4.0	3.8	3.5	3.4	0.66	0.36
Delivery Gauge Reading (in m of water)	8.2	15.0	18.9	21.20	24.85	24.95
Power input to the pump (in KW)	4.55	4.85	3.85	2.95	2.75	2.05

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 1500 r.p.m.

i) Total Head (H) Vs. Discharge (Q)
ii) Pump input Power (P) Vs. Discharge (Q)

[Turn over

iii) Overall Efficiency (η_o) Vs. Discharge (Q).

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

5. a) Define Multistaging of Centrifugal pump and with diagrams explain centrifugal pump in:**1) series connection 2) Parallel connection.** (10)

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	40.00	0	45.00
0.12	35.00	0.13	40.00
0.20	30.00	0.22	35.00
0.27	22.00	0.30	28.00
0.30	16.00	0.35	18.00

Determine the head-capacity curves when these pumps are in series connection using graph paper.

(10)

6. a) Explain how the positioning of a centrifugal pump above the sump or a reaction turbine above the tail race can affect the possibilities of cavitation. (5)

b) A centrifugal pimp is to discharge 100 liters/s at a speed of 1450 rpm against a head of 15 m. The impeller has an outer diameter of 25 cm with a width at the outlet of 6 cm. The manometric efficiency is 0.8. Determine the ratio of pressure head to velocity head created by the impeller. Deduce the relation which you are using. (10)

c) Show that the angle of inclination of the flow in the casing of a centrifugal pump remains constant at all radii.

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7. 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 30^0. Assuming radial vanes at both inlet and outlet and flow velocity remaining constant, determine the hydraulic efficiency. (10)

8. a) Discuss analytically the possible values of degrees of reaction for different types of turbines. (8)

b) Obtain an expression for the degree of reaction of a reaction turbine in terms of blade angles. Hence find the degree of reaction of a Francis turbine which works under a head of 250 m and discharges 15 m^3 /s while rotating at 450 RPM. The inlet diameter of the rotor is 2 m and the blade width at inlet is 28 cm. Assume hydraulic and overall efficiencies to be 0.94 and 0.92 respectively. (12)

9. Write short notes on any four of the followings: (4 X 5 =20)

a) Surge Tank b) Priming of a Centrifugal Pump c) Cavitation d) Specific speed e) Draft tube