Ref. No. : Ex/ME/5/T/213/2024

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) SECOND YEAR FIRST SEMESTER - 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. a) What do you understand by geometrically similar turbo machines? Define the non-dimensional "Specific Speed" and "unit quantities" of an incompressible-flow Turbo-machine. (12)

b) Explain the "Affinity Law" in connection with the performance of a Turbo-Pump. (8)

2. What is dimensional analysis? By using Dimensional analysis obtain non-dimensional functional relationship between the variables of an incompressible turbo-machinery. (20)

3. a) Explain the terms 'Flow Co-efficient', 'Head Co-efficient' and 'Power Co-efficient'. Why they are so important? (10)

b) Find the height from the water surface at which a centrifugal may be installed in following case to avoid cavitation.
Given:
Atmospheric pressure=1.01 bar
Vapour pressure=0.022 bar
Inlet and other losses in suction pipe = 1.42 m
effective head of the pump = 49 m
Cavitation parameter, $\sigma = 0.115$ (10)

4. 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.)	1400	1420	1440	1460	1480	1500
Discharge (Lit./min.)	700	680	660	600	470	0
Suction Gauge Reading (in m of water)	4.0	3.8	3.4	3.2	0.50	0.4
Delivery Gauge Reading (in m of water)	26.0	21.0	18	16	22	24.0
Power input to the pump (in KW)	4.8	4.6	3.8	2.9	2.7	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 1500 r.p.m.

i) Total Head (H) Vs. Discharge (Q)

[Turn over

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. (20)

5. a) What do you understand by Multistaging of Centrifugal pump? Explain with neat diagram the following:
   1) Centrifugal Pumps in series connection
   2) Centrifugal Pumps in Parallel connection. (08)

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	40.0	0	45.00
0.12	35.0	0.135	40.00
0.20	30.0	0.22	35.00
0.27	22.00	0.32	28.00
0.30	15.50	0.36	18.00

Determine the head-capacity curves when these pumps are in parallel connection using graph paper. (12)

6. a) Explain centrifugal pump priming operation. Explain unit quantities? (10)

b) A centrifugal pump running at 1000 r.p.m. is working against a total head of 35 m. The external diameter of the impeller is 480 mm and outlet width is 60 mm. If the vane angle at outlet is 30° and manometric efficiency is 75%, determine:
   i) Flow velocity at outlet ii) Absolute velocity of water leaving the vane
   ii) Angle made by the absolute velocity at outlet with the direction of motion at Outlet (iii) Rate of flow through the pump. (10)

7. a) Explain the system curve, design point and operating point in connection with a centrifugal pump and pipeline assembly. (10)

b) A 1200 m long pipeline having a diameter of 185 mm is used to pump water from a reservoir to storage tank, where the water levels stands at a height of 80 m above the water level in the reservoir. The Darcy's friction factor for the pipeline is 0.03. The pump connected to this pipeline has the Head-Discharge characteristics as tabulated below:

Total Head (H) in meter	45	72	76	96
Discharge (Q) in lit/min	2200	2000	1550	920

Plot the Head vs. Discharge Curve for this pump as well as the System Head curve for the pipeline system and thus obtain the point of operation. (10)

8. a) Distinguish between 'available NPSH' and required 'NPSH' of a turbo pump. (6)

b) A Centrifugal pump running at 500 r.p.m. has an outlet vane angle of 65°. The velocity of flow through the impeller is constant at 2.5 m/s. The manometric head is 24 m and the manometric efficiency is 75 %. The outer diameter is twice the inlet diameter. Assuming that the water enters without whirl, find (i) the inlet and outlet diameter of the impeller (ii) Inlet vane angle. (14)

9. a) explain the function of wicket gates and draft tube in a reaction turbine. (8)

b) A vertical shaft Francis turbine has an overall efficiency of 80 % and runs at 12 revolutions per second with a water discharge of 15 m^3/s. The velocity at the inlet of the spiral casing is 9.0 m/s and pressure head at this point is 320 m, the centerline of the casing inlet being 4.0 m above the tailrace level. The diameter of the runner at inlet is 1.5 m and width at inlet is 300 mm. The hydraulic efficiency 70%, determine:
i) Output power II) The dimensionless specific speed
III) The guide vane angle iv) The runner blade angle at inlet. (12)

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

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