Total No. of Questions : 12]

SEAT No. :

P1059

[Total No. of Pages : 4

[4659]-37
B.E. (Mechanical Engineering)
c-DESIGN OF PUMPS, BLOWERS AND COMPRESSORS
(2008 Course) (402044) (Semester-I) (Elective-I)

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

Instructions to the candidates:

1) ***Answer any three questions from each section.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables, slide rule, Mollier charts, and electronic pocket calculator and steam tables are allowed.***
6) ***Assume suitable data, if necessary.***

SECTION-I

Q1) a) Explain the following terms: **[8]**

i) Flow Machines ii) Turbines

iii) Pumps iv) Compressible Flow Machines

b) A turbo blower develops 750mm W.G. at a speed of 1480 rpm and a flow rate of 38 m^3/s. It is desired to build a small model which develops the same head at a higher speed (2490 rpm) and low discharge. Determine the specific speed and the flow rate through the model. **[8]**

OR

Q2) a) Explain the performance characteristics of pumps, compressors, fans and blowers. **[10]**

b) Write equations of energy transfer between fluid and rotor. **[6]**

Q3) a) The impeller of a centrifugal pump has 1.4 m outside diameter. It is used to lift 1800 liters of water per second against a head of 10m. Its Vanes make an angle of 45° with the direction of motion at outlet and runs at 400 rpm. If the radial velocity of flow at outlet is 3.5 m/s, find the manometric efficiency. Also find the power required if the overall efficiency is 82%. **[8]**

b) Explain various efficiencies of centrifugal pump. **[8]**

OR

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Q4) a) Explain various types of characteristic curves usually prepared for centrifugal pumps. **[8]**

b) What is NPSH? Derive the expression of the same. Find the height from the water surface at which a centrifugal pump may be installed in the following case to avoid cavitation: Atmospheric pressure = 1.01 bar; vapour pressure = 0.022 bar; losses in suction pipe = 1.42m; effective head of pump = 49m; and cavitation factor = 0.115. **[8]**

Q5) a) Explain the following terms: **[8]**

i) Static Suction Head ii) Static Discharge Head

iii) Total Static Head

b) Explain the design procedure of centrifugal pump. **[10]**

OR

Q6) a) Explain various forms of corrosion occurred in hydraulic machines. **[8]**

b) A centrifugal pump running at 1450 rpm has the characteristic as given below: **[10]**

Discharge (Lit/sec)	11.3	16.9	22.6	28.3	34	39.6	45.2
Head (m)	25.8	25	24.1	23.2	21.4	18.9	15.8
Efficiency %	65	70	73	74	72	69	62

Draw the operating characteristic of the pump and determine its specific speed. The pump lifts water against a static head of 12m through a long pipeline in which the loss of head in meters, due to friction is given by the expression, hf = 0.012 Q2, where Q is the discharge in liters/sec. The minor losses in the pipe may be neglected. Determine the power required to drive the pump.

SECTION-II

Q7) a) Explain the different applications of compressors, fans and blowers. **[8]**

b) An axial fan stage consisting of rotor and UGVs for-ve inlet swirl and to eliminate outlet swirl, has the following data: **[10]**

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Rotor blade air angle at inlet = 86° Tip diameter = 60 cm

Hub diameter = 30 cm Rotational speed = 960 rpm

Power required = 2 kW Flow coefficient = 0.245

(Inlet flow conditions P_1 = 1.02 bar, T_1 = 316 K)

Determine the rotor blade angle at exit, the flow rate, stage pressure rise, overall efficiency, degree of reaction and specific speed.

OR

Q8) a) Explain functions of an airfoil and discuss the characteristic curves of airfoils. **[8]**

b) Prove the following relations for an axial fan stage with UGVs and DGVs:

$(\Delta p)_{st} = 2\rho u^2 (\Phi \tan \beta_2 - 1)$, $\psi = 4(\Phi \tan \beta_2 - 1)$ and R = 1. **[10]**

Q9) a) What are the main causes of noise generation? What are the methods of reducing fan noise? **[8]**

b) A centrifugal blower takes in 180 m^3/min of air at P_1 = 1.013 bar and T_1 = 43°C, and delivers it at 750 mm of W.C. Taking the efficiencies of the blower and drive as 80% and 82% respectively, determine the power required to drive the blower and the state of air at exit. **[8]**

OR

Q10)a) Explain briefly what is the purpose of inlet guide vanes and inducer blades. Why is the radial-tipped impeller most used in centrifugal compressor stages? **[8]**

b) Write a short note on: **[8]**

i) Surge and stall ii) Cascade variables

Q11)a) State design considerations and empirical relations used to determine various fan design parameters. **[6]**

b) An axial compressor stage has the following data: **[10]**

Temperature and pressure at entry 300 K, 1 bar

Degree of reaction = 50% Mean blade ring diameter = 36 cm

Rotational speed = 18000 rpm Blade height at entry = 6 cm

Air angle at rotor and stator exit = 25°

Flow coefficient = 0.53 Work-done factor = 0.88

Stage efficiency = 85% Mechanical efficiency= 96.7%

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Determine:

i) Air angles at rotor and stator entry.

ii) The mass flow rate of air.

iii) The power required to drive the compressor.

iv) The loading coefficient.

v) The pressure ratio developed.

vi) The Mach number at stator entry.

OR

Q12)a) What is "slip factor"? What is its effect on the flow and the pressure ratio in the stage? **[6]**

b) The impeller tip speed of a centrifugal compressor is 370 m/s, slip factor is 0.90 and the radial velocity component at the exit is 35 m/s. If the flow area at the exit is 0.18 m^2 and compressor efficiency is 0.88, determine the mass flow rate of air and the absolute Mach number at the impeller tip. Assume air density = 1.57 kg/m^3 and inlet stagnation temperature is 290K. Neglect the work input factor. Also, find the overall pressure ratio of the compressor. **[10]**

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