B.E. (Sem VII) (CBSGS) (Mechanical Engg.) 04th Dec. 2015

Mechanical Utility Systems 11.00 am to 2.00 pm

QP Code : 5933

(3 Hours) [Total marks : 80

Note: 1) Question no. 1 is compulsory.

2) Attempt any **three** questions out of the remaining **five** questions.

3) Clearly mention the assumptions made if any.

Q.1 Solve any four 20

a) Differentiate between reciprocating compressors and rotary compressors

b) Advantages of multistaging of reciprocating compressors

c) Define following terms in centrifugal pump

1) Suction head 2) Delivery head 3) Static head 4) Manometric head

d) A single-acting reciprocating pump, running at 50 rpm, delivers 0.01 m^3/s of water. The diameter of the piston is 200 mm and stroke length 400 mm. Determine: i) The theoretical discharge of the pump, ii) Co-efficient of discharge and iii) Slip and the percentage slip of the pump.

e) Discuss the performance characteristics of reciprocating pumps

f) What are the applications of compressed air in industry?

Q.2 a) What are the axial thrust in centrifugal pumps ? Discuss the methods of balancing the axial thrust. 8

b) In a trial on a two-stage, single acting, reciprocating air compressor, following data were recorded.

1) Free air delivery per minute = 6 m^3

2) Free air conditions = 1 bar, 27°C

3) Delivery pressure = 30 bar

4) Compressor speed = 300 rpm

5) Intermediate pressure = 6 bar

6) Temperature at the inlet of HP cylinder = 27°C

7) Law of compression = $PV^{1.3}$

8) Mechanical efficiency = 85 %

9) Stroke to bore ratio for LP cylinder = 1.2

Calculate a) Cylinder diameters b) Power input, neglecting clearance volume 12

Q.3 a) An axial –flow compressor has a constant axial velocity of 150 m/s and 50% reaction. The mean diameter of the blade ring is 35 cm and speed is 15,000 rpm. The exit angle of the blade is 27°.Calculate blade angle at inlet and work done per kg of air. 8

b) Explain construction and working of centrifugal pump with neat sketch 6

c) A single-stage centrifugal pump with impeller diameter of 30 cm rotates at 2000 rpm and lifts 3 m^3 of water per second to a height of 30 m with an efficiency of 75%. Find the number of stages and diameter of each impeller of a similar multistage pump to lift 5 m^3 of water per second to a height of 200 m when rotating at 1500 rpm. 6

Q.4 a) Explain construction and working of multi-stage, reciprocating air compressor with intercooler with help of neat labeled schematic diagram and P-V diagram. 10

b) A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000 rpm works against a total head of 40 m. The velocity of flow through the impeller is constant and equal to 2.5 m/s. The vanes are set back at an angle of 40° at outlet. If the outer diameter of the impeller is 500 mm and width at outlet is 50 mm, determine: i) Vane angle at inlet, ii) Work done by impeller on water per second and iii) Manometric efficiency. 10

Q.5 a) A centrifugal compressor running at 12000 rpm delivers 600 m^3/min of free air. The air is compressed from 1 bar and 27°C to a pressure ratio of 4 with an isentropic efficiency of 85%. The blades are radial at the impeller outlet and flow velocity of 60 m/s may be assumed throughout constant. The outer radius of the impeller is twice the inner one and slip factor is 0.9. Calculate: i) Final temperature of air, ii) Power input to compressor, iii) Impeller diameter at inlet and outlet and iv) Width of impeller at inlet. 10

b) Write down energy conservation opportunities in pumping system 10

Q.6 Write short note on following (any four) 20

a) Features of gear pump

b) Air vessels

c) Net positive suction head (NPSH)

d) Diffuser system

e) Leak detection in compressed air net work

d) Choking and surging in case of centrifugal compressor