MECH/VII/CBGS/MVS/ 08-12-2016

Mechanical Utility Systems

QP CODE : 793302

(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 centrifugal compressor and axial compressor.

b) Explain Screw pump with neat diagram.

c) Define following terms for reciprocating compressors,

1) Mechanical efficiency

2) Indicated power

3) Volumetric efficiency

4) Free Air Delivery

d) A single-acting, single-cylinder reciprocating air compressor is compressing 20 kg/min of air from 110 kPa, 30^0C to 600 kPa and delivers it to a receiver. Law of comparision is $pV^{1.25}$ = constant. Mechanical efficiency is 80%. Find the power input to compressor, neglecting losses due to clearance, leakages and cooling.

e) Write a note on leak detection in compressed air network.

Q.2 a) Explain construction and working of single-stage, double-acting reciprocating air compressor with neat labelled diagram. **10**

b) A double-acting reciprocating pump, running at 40 rpm, is discharging 1 m^3 of water per minute. The pump has a stroke of 400 mm. The diameter of piston is 200 mm. The delivery and suction head are 20 m and 5 m respectively. Find the slip of the pump and power required to drive the pump. **10**

Q.3 a) Explain construction and working of axial compressor with neat diagram. **8**

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b) 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. 12

Q.4 a) What is cavitation? State the effects of cavitation and what precautions should be taken against cavitation. 8

b) A two-stage, single-acting reciprocating air compressor takes in air at 1 bar and 300 K. Air is discharged at 10 bar. The intermediate pressure is ideal for minimum work and perfect inter-cooling. The law of compression is $pV^{1.3}$ = constant. The rate of discharge is 0.1 kg/s. Calculate: 1) Power required to drive the compressor,

2) Saving in work in compression with single stage compression,

3) Isothermal efficiency,

4) Heat transferred in intercooler. Take R= 0.287 kJ/kg K and C_p = 1 kJ/kg K . 12

Q.5 a) Write down the energy conservation opportunities in pumping system. 6

b) An axial- flow compressor has a constant axial velocity of 150 m/s and 50% reaction. The mean diameter of blade ring is 35 cm and speed is 15,000 rpm. The exit angle of blade is 27^0. Calculate blade angle at inlet and work done per kg of air. 8

c) The internal and external diameters of a centrifugal pump are 200 mm and 400 mm resp. The pump is running at 1200 rpm. The vane angles of the impeller at inlet and outlet are 20° and 30° resp. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water 6

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

a) Trouble shooting in centrifugal pump.

b) Model testing of centrifugal pump.

c) Diffuser system in centrifugal compressor.

d) Losses in axial compressor.

e) Applications of compressed air in industry.
