B.E. (Mechanical) (Sem-VII) (CBSGS) (R-2012)

Paper / Subject Code: 42803 / Mechanical Utility Systems

Date – 20/11/19

(Revised course)

Time duration: 3 Hours [Total Marks: 80]

Note:

1) Question No. 1 is compulsory
2) Attempt any three questions out of the remaining five questions
3) Assume suitable data if required

Q.1 Solve any four (20)

a) Derive the equation for work done per kg of air in case of a single stage reciprocating compressor without clearance.

b) Explain the working of an axial flow compressor with neat labeled diagram.

c) Explain the working of gear pump.

d) Describe the function of air vessel in reciprocating pump with the help of neat sketch.

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

Q.2 a) Explain the construction and working of a centrifugal pump with nest sketch. Why is priming necessary in a centrifugal pump. (10)

b) A single acting reciprocating pump has a plunger of 80 mm diameter and a stroke of length 150 mm. It takes its supply of water from a sump 3 m below the pump through a pipe 4.5 m long and 30 mm diameter. It delivers water to a tank 12 m above the pump through a pipe 25 mm diameter and 15 m long. If separation occurs at 78 kN/m^2 below atmospheric pressure, find the maximum speed at which the pump may be operated without separation, assume the plunger to have simple harmonic motion. (10)

Q.3 a) Why inter-cooling is used in multi-stage compressor? Derive an expression for intermediate pressure in a two-stage compressor when inter-cooling is perfect. (10)

b) An axial flow compressor with an overall isentropic efficiency of 90% draws air at 25°C and compresses it in the pressure ratio of 3:1. The mean blade speed and flow velocity are constant throughout the compressor.

Assuming 50% reaction blading and taking blade velocity as 200 m/s. Take $\alpha 1=12°$, $\beta 1=42°$. Calculate: (i) Flow velocity (ii) Number of stages (10)

TURN OVER

Q.4 a) The impeller of a centrifugal pump having external and internal diameters 500 mm and 250 mm respectively, width at outlet 50 mm and running at 1200 r.p.m works against a head of 48 m. The velocity of flow through the impeller is constant and equal to 3 m/s. The vanes are set back at an angle of 40° at outlet. Determine: (i) Inlet vane angle (ii) workdone by impeller on water per second and (iii) manometric efficiency. (10)

b) Write a note on the energy conservation opportunities in pumping system. (10)

Q.5 a) A single-stage reciprocating compressor takes $1m^3$ of air per minute at 1.01325 bar and 15°C and delivers at 7 bar. Assume that law of compression is $PV^{1.35}$=constant, and that clearance is negligible. If this compressor is driven at 300 rpm, stroke to bore ratio of 1.5:1 and single acting, calculate the indicated power, the cylinder bore required, the power required to drive the compressor, if the mechanical efficiency is 85% and that of motor transmission is 90% and the iso-thermal efficiency of this compressor. (12)

b) What is cavitation? State the effects of cavitation and what precautions should be taken against cavitation. (08)

Q.6 Solve the following: (Any four) (20)

a) What do you mean by net positive suction head and its significance?

b) Applications of compressed air in industry.

c) Enumerate the losses which occur when a centrifugal pump operates.

d) What is octopus network and its limitations?

e) Draw and comment on performance characteristics of centrifugal pump.
