

(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 neat 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 $\alpha_1=12^\circ$, $\beta_1=42^\circ$.

Calculate: (i) Flow velocity (ii) Number of stages (10)

- 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 1 m^3 of air per minute at 1.01325 bar and 15°C and delivers at 7 bar. Assume that law of compression is $PV^{1.35}=\text{constant}$, 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.