

(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) Clearly mention the assumptions made if any.

Q 1. Attempt any 4 of the following; (20)

- Differentiate between reciprocating compressor and centrifugal compressor
- Explain external gear pump with diagram.
- Explain methods of improving isothermal efficiency of reciprocating compressor.
- A double acting reciprocating pump takes in water from 3m and delivers at 45 m when running at 50 rpm. Its diameter and stroke are 18 cm and 36 cm respectively. Find the power required to drive the pump if mechanical efficiency is 85%. Also find the discharge of pump. Neglect the area of piston rod.
- Write a note on load-unload test.

Q 2. a) Explain construction and working of multi-stage reciprocating air compressor with intercooler with help of neat labelled schematic diagram and PV diagram. (8)

b) A centrifugal pump discharges  $0.15\text{m}^3/\text{s}$  of water against a head of 12.5 m, the speed of the impeller being 600 rpm. The outer and inner diameters of impeller are 500 mm and 250 mm respectively and the vanes are bent back at  $35^\circ$  to the tangent at exit. If the area of flow remains  $0.07\text{m}^2$  from inlet to outlet, calculate: (i) Manometric efficiency of the pump, (ii) Vane angle at inlet, and (iii) Loss of head at inlet to impeller when the discharge is reduced by 40% without changing the speed. (12)

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

b) A centrifugal compressor running at 1440 rpm, handles air at 101 kPa and  $20^\circ\text{C}$  and compresses it to a pressure of 6 bar isentropically. The inner and outer diameters of the impeller are 14 cm and 28 cm respectively. The width of the blade at inlet is 2.5 cm. The blade angles are  $16^\circ$  and  $40^\circ$  at entry and exit. Calculate mass flow rate of air, degree of reaction, power input and width of blades at outlet. (12)

Q 4. a) Derive an expression for work done by the impeller of a centrifugal pump on liquid per second per unit weight of liquid. (8)

b) The LP cylinder of a two-stage double-acting reciprocating air compressor running at 120 rpm has a 50 cm diameter and 75 cm stroke. It draws air at a pressure of 1 bar and  $20^\circ\text{C}$  and compresses it adiabatically to a pressure of 3 bar. The air is then delivered to the inter-cooler,

TURN OVER

where it is cooled at constant pressure to 35°C and is then further compressed polytropically (index  $n=1.3$ ) to 10 bar in HP cylinder. Determine the power required to drive the compressor. The mechanical efficiency of the compressor is 90% and motor efficiency is 86%. (12)

Q 5. a) Two geometrically similar centrifugal pumps are running at the same speed of 1000 rpm. One pump has an impeller diameter of 0.3 meter and lifts water at rate of 20 liters per second against a head of 15 meters. Determine the head and impeller diameter of the other pump to deliver half the discharge. (6)

b) An axial-flow compressor of 50% reaction has a blade outlet angle of 30°. The flow velocity is 0.5 times the mean blade velocity. The speed of the rotor is 7500 rpm. The stagnation condition of air at the entry is 1.013 bar and 5°C and the static pressure at this section is 0.91 bar. Draw the velocity triangle and find the power required to run the compressor, mass-flow rate and mean diameter of rotor. The mean flow area is 0.35 m<sup>2</sup>. (8)

c) Explain working of a single-stage reciprocating air compressor with neat labelled diagram. (6)

Q 6. Attempt any four of the following; (20)

- Trouble shooting in centrifugal pump
- Variable speed drive
- Screw pump
- Air vessels
- Choking and surging in centrifugal pump
- Methods of improving efficiency of pumping system