

Con. 5841-09.

SP-6509

(4 Hours)

[Total Marks : 100]

N.B. : (1) Question No. 1 is compulsory.

(2) Answer any **three** of the remaining **five** questions.(3) Assume **suitable data** wherever **required**.(4) Use of **standard** design data books is **permitted**.

1. (a) Derive Lewis equation for the design of gear teeth. What are the assumptions made in above ? Are these realized in practice? If not how they are taken into account ? 12
- (b) What are self energizing and self locking brakes ? State their assumptions. 5
- (c) Explain static and dynamic seals with examples. 4
- (d) What are the limitations on the number of disks of a disk clutch ? 4
2. (a) A spur gear has following specifications. 12
- Module = 3
- Face width = 30 mm
- Pressure angle =  $20^\circ$
- Output shaft speed = 200 rpm
- Number of teeth on pinion = 20
- Material for pinion 40 Cr1 with ultimate tensile strength  $950 \text{ N/mm}^2$  and surface hardness 460BHN
- Number of teeth on gear = 56
- Material for gear steel C50 with ultimate tensile strength  $800 \text{ N/mm}^2$  and surface hardness 380 BHN
- Gears are commercially cut with grade A. Gear mounting is symmetric.
- Estimate power rating of pair based on (i) Beam strength (ii) Wear.
- (b) Design a worm and worm wheel gear drive having following data :— 13
- Worm shaft speed 800 RPM
- Reduction ratio 25
- Power to be transmitted 12 kW from an electric motor.
- Driven machine has medium shock and duty of 12-14 hrs/day
- Design should be done based on strength and wear criteria.
3. (a) A hydrodynamically lubricated journal bearing is required to support a radial load of 7 kN for an reciprocating air compressor. Normal operating speed is 300 rpm. Design the bearing to suit above data for an average clearance of a medium running fit. Bearing should operate at steady state without special cooling. Specify oil and its quality to be used and show all calculations to support your conclusion. 17
- (b) Determine the expected life of SKF bearing number 22216, if it is subjected to an axial load of 20 kN and radial load of 80 kN. Outer race rotates at 65 rpm. Operating temperature is  $140^\circ\text{C}$ . Probability of survival 92%. 8

[TURN OVER]

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4. (a) A multi cylinder refrigeration compressor is driven by an electric motor which is rated at 30 kW at 960 rpm. Compressor speed is 410 rpm and is required to operate 10-12 hrs/day. Select suitable size and number of V belts for above requirement if average life of belt is 1 Yr. 13
- (b) A single cylinder, single acting, four stroke oil engine develops 18.75 kW indicated power at 300 rev/min. The work done by the gases during the expansion stroke is 2.3 times the work done on the gases during the compression stroke and work done during the suction and exhaust strokes is negligible. The speed is to be maintained within 1 % of the mean speed, find the flywheel effect. 12
5. (a) An engine developing 30 kW at 1250 rev/min is fitted with cone clutch built into the flywheel. The cone has a face angle of  $12.5^\circ$  and a maximum diameter of 0.35 m. the coefficient of friction is 0.2. The normal pressure on the clutch face is not to exceed  $0.085 \text{ N/mm}^2$  :— 12
- Determine the face width required.
  - Determine the spring pressure required to engage this clutch.
  - Design the spring.
- (b) A press is designed to punch 20 mm holes in a 20 mm thick plate. The material of the plate has an ultimate tensile stress of  $360 \text{ MN/m}^2$ . The press is operated at 30 rev/min, through gears having the ratio of 8:1. The punching operation takes place over  $75^\circ$  of the eccentric travel and speed fluctuation is to be limited to 15%. The overall mechanical efficiency is 80%. 13
- For a radius of 0.5 m determine the necessary cross section of the rim.
  - What is the total weight of the flywheel ?
  - What KW motor must be supplied to the press if (1) the flywheel is fitted (2) Flywheel is not there. Comment on the answer.
6. A rotary disc cam with central translatory follower has following motion. 25
- Forward stroke of 25 mm in  $70^\circ$  of cam rotation with cycloidal motion. Return stroke of 25 mm in  $50^\circ$  of cam rotation with SHM. Remaining is dwell.
- Mass of follower is 1 Kg. cam shaft speed is 600 rpm. Maximum pressure angle during forward stroke is  $25^\circ$  and force 600 N and during return stroke is  $30^\circ$  and force 200 N. Design the cam, the roller follower along with its pin and spring. Also calculate the maximum torque on cam shaft.

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