

Total No. of Questions : 8]

SEAT No. :

PE4339

[Total No. of Pages : 4

[6582]-113

**S.E. (Robotics and Automation)**  
**DESIGN OF MACHINE ELEMENTS**  
**(2019 Pattern) (Semester - IV) (211510)**

Time : 2½ Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8.
- 2) Figures to the right indicate full marks.
- 3) Neat diagrams must be drawn wherever necessary.
- 4) Use of non-programmable electronic pocket calculator is allowed.
- 5) Assume suitable data, if necessary.

- Q1)** a) Explain along with sketch different Types of Screw Threads. [4]  
b) Derive expression for Torque Required to Raise Load by Square Threaded Screws. [8]  
c) The nominal diameter of a triple threaded square screw is 50 mm, while the pitch is 8 mm. It is used with a collar having an outer diameter of 100 mm and inner diameter as 65 mm. The coefficient of friction at the thread surface as well as at the collar surface can be taken as 0.15. The screw is used to raise a load of 15 kN. Using the uniform wear theory for collar friction calculate: [6]  
i) Torque required to raise the load;  
ii) Torque required to lower the load; and  
iii) The force required to raise the load, if applied at a radius of 500 mm

OR

- Q2)** a) Screw press is to exert a force of 40 kN. The unsupported length of the screw is 400 mm. Nominal diameter of screw is 50 mm. The screw has square threads with pitch equal to 10 mm. The material of the screw and nut are medium carbon steel and cast iron respectively. For the steel used take ultimate crushing stress as 320 MPa, yield stress in tension or compression as 200 MPa and that in shear as 120 MPa. Allowable shear stress for cast iron is 20 MPa and allowable bearing pressure between screw and nut is 12N/mm<sup>2</sup>. Young's modulus for steel = 210 kN/mm<sup>2</sup>. Determine the factor of safety of screw against failure. Find the dimensions of the nut. What is the efficiency of the arrangement? Take coefficient of friction between steel and cast iron as 0.13. [8]  
b) Derive the expression for Efficiency of Self Locking Screws. [4]

P.T.O.

- c) The cutter of a broaching machine is pulled by square threaded screw of 55 mm external diameter and 10 mm pitch. The operating nut takes the axial load of 400 N on a flat surface of 60 mm and 90 mm internal and external diameters respectively. If the coefficient of friction is 0.15 for all contact surfaces on the nut, determine the power required to rotate the operating nut when the cutting speed is 6 m/min. Also find the efficiency of the screw. [6]

**Q3) a)** List out the different Material used in Spring. [5]

- b) Define the Following Terms: Solid length, Free length, Spring index, Spring rate. [4]

- c) It is required to design a helical compression spring subjected to a maximum force of 1250 N. The deflection of the spring corresponding to the maximum force should be approximately 30 mm. The spring index can be taken as 6. The spring is made of patented and cold-drawn steel wire. The ultimate tensile strength and modulus of rigidity of the spring material are 1090 and 81 370 N/mm<sup>2</sup> respectively. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring and calculate: [8]

- i) wire diameter;
- ii) mean coil diameter;
- iii) number of active coils

OR

**Q4) a)** Explain the concept of Surge in Springs. [4]

- b) A compression coil spring made of an alloy steel is having the following specifications Mean diameter of coil = 50 mm; Wire diameter = 5 mm; Number of active coils = 20. If this spring is subjected to an axial load of 500 N; calculate the maximum shear stress (neglect the curvature effect) to which the spring material is subjected. [6]

- c) At the bottom of a mine shaft, a group of 10 identical close coiled helical springs are set in parallel to absorb the shock caused by the falling of the cage in case of a failure. The loaded cage weights 75 kN, while the counter weight has a weight of 15 kN. If the loaded cage falls through a height of 50 metres from rest, find the maximum stress induced in each spring if it is made of 50 mm diameter steel rod. The spring index is 6 and the number of active turns in each spring is 20. Modulus of rigidity,  $G = 80 \text{ kN/mm}^2$ . [7]

- Q5)** a) Write a short note classification of Gear. [4]  
b) Comparison Between Involute and Cycloidal Gears Explain. [4]  
c) It is required to design a pair of spur gears with  $20^\circ$  full-depth involute teeth based on the Lewis equation. The velocity factor is to be used to account for dynamic load. The pinion shaft is connected to a 10 kW, 1440 rpm motor. The starting torque of the motor is 150% of the rated torque. The speed reduction is 4 :1. The pinion as well as the gear is made of plain carbon steel 40C8 ( $S_{ut} = 600 \text{ N/mm}^2$ ). The factor of safety can be taken as 1.5. Design the gears, specify their dimensions and suggest suitable surface hardness for the gears. [10]

OR

- Q6)** a) Explain causes of Gear Tooth Failure in detail. [4]  
b) A reciprocating compressor is to be connected to an electric motor with the help of spur gears. The distance between the shafts is to be 500 mm. The speed of the electric motor is 900 r.p.m. and the speed of the compressor shaft is desired to be 200 r.p.m. The torque, to be transmitted is 5000 N-m. Taking starting torque as 25% more than the normal torque, determine: [9]  
i) Module and face width of the gears using  $20^\circ$  stub teeth, and  
ii) Number of teeth and pitch circle diameter of each gear.  
Assume suitable values of velocity factor and Lewis factor.  
c) A bronze spur pinion rotating at 600 r.p.m. drives a cast iron spur gear at a transmission ratio of 4 : 1. The allowable static stresses for the bronze pinion and cast iron gear are 84 MPa and 105 MPa respectively. The pinion has 16 standard  $20^\circ$  full depth involute teeth of module 8 mm. The face width of both the gears is 90 mm. Find the power that can be transmitted from the standpoint of strength. [5]

- Q7)** a) Explain in details types of Bearing. [4]  
b) A shaft rotating at constant speed is subjected to variable load. The bearings supporting the shaft are subjected to stationary equivalent radial load of 3 kN for 10 percent of time, 2 kN for 20 percent of time, 1 kN for 30 percent of time and no load for remaining time of cycle. If the total life expected for the bearing is  $20 \times 10^6$  revolutions at 95 percent reliability, calculate dynamic load rating of the ball bearing. [7]  
c) Select a single row deep groove ball bearing for a radial load of 4000 N and an axial load of 5000 N, operating at a speed of 1600 r.p.m. for an average life of 5 years at 10 hours per day. Assume uniform and steady load. [6]

OR

- Q8) a) Write a short on Lubrication and Mounting of Bearing. [5]
- b) A 22KW, 1440 rpm Electric Motor is directly coupled to a shaft of 25 mm diameter, which supported by cylindrical roller bearing. The shaft transmits power to another line shaft through the flat pulley of 300 mm diameter which is placed mid-way between two bearing. The coefficient of friction between the belt and pulley is 0.3, while angle of lap is  $180^\circ$ . The belt is horizontal, the load factor is 1.5 if expected life is 50,500 hours, select bearing from manufacturing catalogues Bearing No – NU2205 and NU–2305 having basic dynamic Capacity C KN is 15.99 and 31.39 Respectively. [8]
- c) Write a short note on Selection of Bearing Life. [4]

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