Total No. of Questions : 8]

SEAT No. :

P-9184

[Total No. of Pages : 4

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S.E. (Robotics and Automation)
DESIGN OF MACHINE ELEMENT
(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) *Use of scientific calculator is allowed.*
3) *Figures to the right side indicate full marks.*

Q1) a) Derive the expression Efficiency of Square Threaded Screws and Maximum Efficiency of a Square Threaded Screw. **[8]**

b) Power screw having double start square threads of 25 mm nominal diameter and 5 mm pitch is acted upon by an axial load of 10 kN. The outer and inner diameters of screw collar are 50 mm and 20 mm respectively. The coefficient of thread friction and collar friction may be assumed as 0.2 and 0.15 respectively. The screw rotates at 12 r.p.m. Assuming uniform wear condition at the collar and allowable thread bearing pressure of 5.8 N/mm^2, find: i) the torque required to rotate the screw; ii) the stress in the screw; and iii) the number of threads of nut in engagement with screw. **[8]**

OR

Q2) a) A power transmission screw of a screw press is required to transmit maximum load of 100 kN and rotates at 60 r.p.m. Trapezoidal threads are as under The screw thread friction coefficient is 0.12. Torque required for collar friction and journal bearing is about 10% of the torque to drive the load considering screw friction. Determine screw dimensions and its efficiency. Also determine motor power required to drive the screw. Maximum permissible compressive stress in screw is 100 MPa **[8]**

Nominal dia, mm	40	50	60	70
Core dia, mm	32.5	41.5	50.5	59.5
Mean dia, mm	36.5	46	55.5	65
Core area, mm^2	830	1353	2003	2781
Pitch, mm	7	8	9	10

b) Explain along with Sketch Different Steps Involved in Design of Screw Jack in Detail. **[8]**

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Q3) a) Derive expression for Deflection of Helical Springs of Circular Wire. **[6]**

b) Explain in detailed Surge in Springs. **[4]**

c) A mechanism used in printing machinery consists of a tension spring assembled with a preload of 30 N. The wire diameter of spring is 2 mm with a spring index of 6. The spring has 18 active coils. The spring wire is hard drawn and oil tempered having following material properties: Design shear stress = 680 MPa Modulus of rigidity = 80 kN/mm^2 Determine: i) the initial torsional shear stress in the wire; ii) spring rate; and iii) the force to cause the body of the spring to its yield strength. **[8]**

OR

Q4) a) Derive the expression for Series and parallel connections. **[6]**

b) 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^2 respectively. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring and calculate: (i) wire diameter; (ii) mean coil diameter; (iii) number of active coils; (iv) total number of coils. **[7]**

c) It is required to design a helical compression spring subjected to a maximum force of 7.5 kN. The mean coil diameter should be 150 mm from space consideration. The spring rate is 75 N/mm. The spring is made of oil-hardened and tempered steel wire with ultimate tensile strength of 1250 N/mm^2. The permissible shear stress for the spring wire is 30% of the ultimate tensile strength (G = 81 370 N/mm^2). Calculate (i) wire diameter; and (ii) number of active coils. **[5]**

Q5) a) Explain the classification Classification of Gears. **[4]**

b) A gear drive is required to transmit a maximum power of 22.5 kW. The velocity ratio is 1:2 and r.p.m. of the pinion is 200. The approximate centre distance between the shafts may be taken as 600 mm. The teeth has 20° stub involute profiles. The static stress for the gear material (which is cast iron) may be taken as 60 MPa and face width as 10 times the module. Find the module, face width and number of teeth on each gear. Check the design for dynamic and wear loads. The deformation or dynamic factor in the Buckingham equation may be taken as 80 and the material combination factor for the wear as 1.4. **[10]**

c) Write A short note on Lewis Equation for Beam Strength. **[4]**

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OR

Q6) a) Write a short note on Gear tooth Failure along with corrective action. **[6]**

b) A pair of spur gears with 20° full-depth involute teeth consists of a 19 teeth pinion meshing with a 40 teeth gear. The pinion is mounted on a crankshaft of 7.5 kW single cylinder diesel engine running at 1500 rpm. The driven shaft is connected to a two-stage compressor. Assume the service factor as 1.5. The pinion as well as the gear is made of steel 40C8 (Sut = 600 N/mm^2). The module and face width of the gears are 4 and 40 mm respectively **[12]**

i) Using the velocity factor to account for the dynamic load, determine the factor of safety.

ii) If the factor of safety is two for pitting failure, recommend surface hardness for the gears.

iii) If the gears are machined to meet the specific cations of Grade 8, determine the factor of safety for bending using Buckingham's equation for dynamic load.

iv) Is the gear design satisfactory? If not, what is the method to satisfy the design conditions? How will you modify the design?

Q7) a) Explain Types of rolling contact bearings along with example. **[4]**

b) A single-row deep groove ball bearing No. 6002 is subjected to an axial thrust of 1000 N and a radial load of 2200 N. Find the expected life that 50% of the bearings will complete under this condition. **[6]**

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. **[8]**

OR

Q8) a) The rolling contact ball bearing are to be selected to support the overhung countershaft. The shaft speed is 720 r.p.m. The bearings are to have 99% reliability corresponding to a life of 24000 hours. The bearing is subjected to an equivalent radial load of 1 kN. Consider life adjustment factors for operating condition and material as 0.9 and 0.85 respectively. Find the basic dynamic load rating of the bearing from manufacturer's catalogue, specified at 90% reliability. **[6]**

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b) Selection of Bearing from the Manufacturing Catalogue explain in detail. **[5]**

c) A single-row deep groove ball bearing has a dynamic load capacity of 40500 N and operates on the following work cycle : **[7]**

i) Radial load of 5000 N at 500 rpm for 25% of the time

ii) Radial load of 10000 N at 700 rpm for 50% of the time; and

iii) Radial load of 7000 N at 400 rpm for the remaining 25% of the time.

Calculate the expected life of the bearing in hours.

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