Indian Institute of Technology Delhi

MCL211: Design of Machines

(II[nd] Semester 2014-15)

MAJOR

06.05.2015 **Time: 120 minutes** **M. Marks: 100**

Q1. Answer each part of following question in a sentence or two. **(6)**

a. Mention two major merits of strain-life method over stress-life method.

b. Why is presetting or set removal done in compression springs?

c. For involute gears, how does pressure angle vary as center-to-center distance increases?

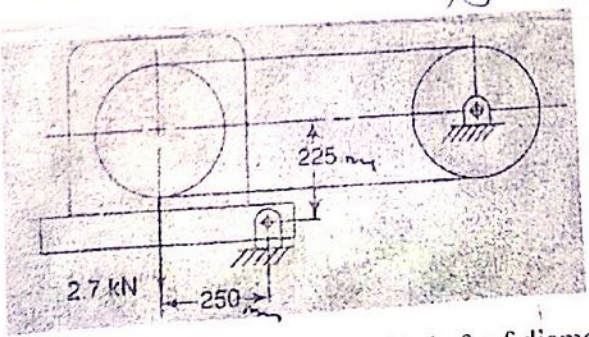
Q2. A gear unit (with 8.33 module, full tooth, 20° pressure angle) has to be designed to reduce the driving motor speed by half. The motor providing 2 kW is to operate at 191 rev/min.

a. Specify the minimum number of teeth for pinion and gear to minimize size of the gear and to avoid teeth interference. **(2)**

b. For the pinion chosen, find factor of safety in bending using AGMA standards. Face width is 4 times circular pitch. The desired life is 12,000 hours with 90% reliability. Gears are made of Grade 2 through hardened steel to a Brinell hardness of 300 (S_t=0.703H_B+113 MPa). Take loading is smooth, form and geometry factors of pinion as 0.303 and 0.3, quality standard as No. 6, and stress-cycle factor given by $1.3558N^{-0.0178}$. **(14)**

Q3. A helical coil compression spring is to be designed for food service machinery with A313 stainless steel wire (G=69 GPa, S_{su}=0.67S_{ut}) with outer diameter less than 62 mm. The load varies from a minimum of 20 N to a maximum of 90 N. The spring rate is 1660 N/m. Use a fatigue design factor n_f of 2 and Goodman-Zimmerli fatigue failure criteria. Taking an initial guess for spring wire diameter as 2 mm (A=1867, m=0.146) and spring ends grounded and squared (N_t=N_a+2, L_O=pN_a+2d, L_s=dN_t). Following the design procedure used in class, determine the various parameters of the spring and then verify the design. **(18)**

Q4. Figure below shows a pivoted motor drive that transmits power using flat belts (horizontal strands) through same size pulleys of 0.3 m diameter. The driving motor weighs 2.7 kN and runs at 800 rev/min. Take the coefficient of friction as 0.2 and belt unit length density as 1.31 kg/m. Determine the tensions in the belt and power capacity for counter-clockwise rotation of motor pulley. **(10)**

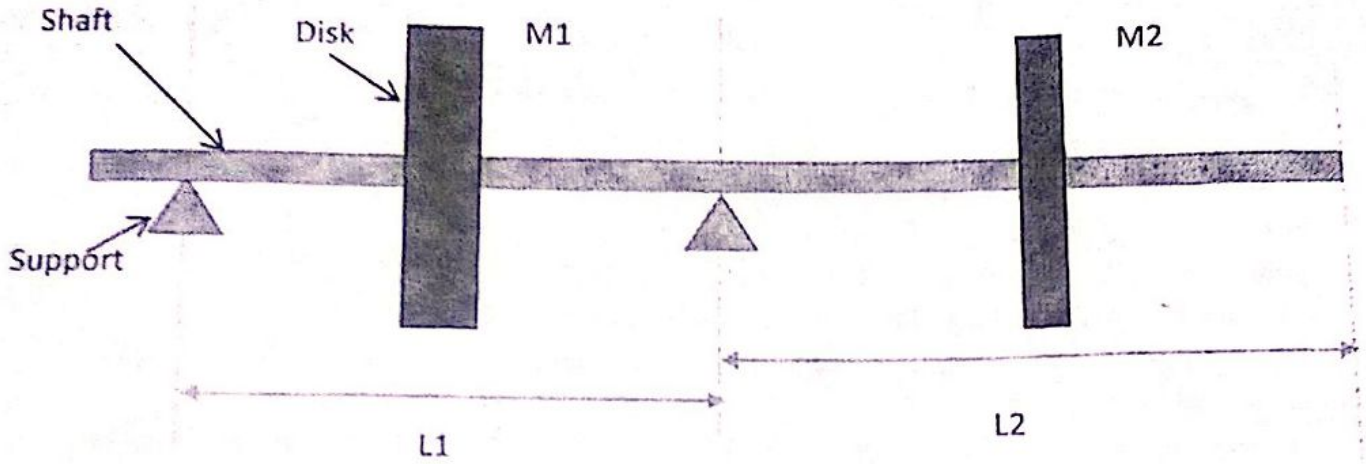


Q5. A pulley is needed to be bored to push fit it on a solid shaft of diameter 20mm. The peak torque required at the pulley is 16.5Nm. The pulley outer diameter is 76mm and its length is 25mm. The shaft material is SAE1020 (Sut = 450MPa, Sy = 260MPa, E=205GPa, Poisson's Ratio=0.28) and the pulley material is C40 grey cast iron (Sut = 290MPa, Tensile strength = 185 MPa, E=95GPa, Poisson's Ratio=0.22). Assume the stress concentration factor K_t=2.4 and the coefficient of friction is 0.11. Estimate tolerances for the shaft and pulley-hole dimensions. **(20)**

Q6. Are the strength requirements same for the pinion and gear materials? How to utilize this information to economize the design of gear. **(5)**

P.T.O.

Q7. Find the natural frequency of the system shown in following figure. **(15)**



Q8. What is the meaning of 'Full Complement' bearing? **(1)**

Q9. Explain "improper fit in assembly of rolling element bearings" by considering two examples. **(3)**

Q10. What is the meaning of internal clearance in rolling element bearings? Sketch the radial internal clearance and axial internal clearance. **(3)**

Q11. What are the basic differences between the operating mechanism of hydrodynamic and hydrostatic lubrications? **(3)**

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