B.E. Food Technology and Bio-Chemical Engineering
2nd Year, 2nd Sem, 2019

Machine Design and Drawing   Time : 3 hrs   Full Marks: 100

(Answer any five questions)

- Data if missing may be assumed suitably.
- The symbols used in the questions, bear their usual meaning.
- Necessary sketches may be drawn as freehand drawings.
- Parts of a question are to be answered serially following their order.
- A horizontal line must be drawn at the end of answers to each question.

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1. Answer all the questions

i) Suggest briefly the steps to be followed in engineering design.

ii) Classify common engineering materials, used in mechanical engineering.

iii) Describe any two important mechanical properties of engineering materials.

iv) Classify common manufacturing methods, used in mechanical engineering.

v) State the significance of manufacturing methods in engineering design process.

vi) What are the differences between fits and tolerances?

vii) Explain the types of fits with neat schematic diagrams.

ix) What is meant by "50 H7 e6"?

x) Explain surface roughness by providing the relevant diagram.

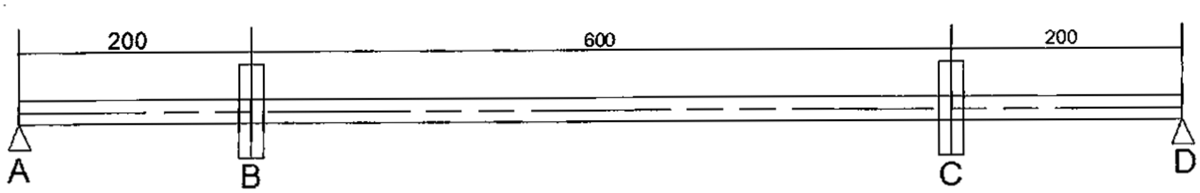
(2x10)

2 a) A rotating shaft is made of plain carbon steel, having yield strength of 400 MPa. It is subjected to axial load of 6500 N, a steady torque of 250 N-m and maximum bending moment of 175 N-m.

i) Calculate the "Equivalent Torsional Moment" and "Equivalent Bending Moment".

ii) Design its diameter based on i) Maximum normal stress theory and ii) Maximum shear stress theory.

b) A rotating shaft is subjected to a steady torque of 330 N-m. It is supported at A and D, and contains two pulleys at location B and C, as shown in figure below. The pulley at B drives a vertical belt drive having net belt tension (T_1+T_2) of 3.68 kN, whereas the horizontal belt drive at C imparts a net belt tension of 7.35 kN. If the yield stress of the shaft material is 400 MPa determine its diameter based on i) Maximum normal stress theory and ii) Maximum shear stress theory.



8+12

[Turn over

3 a) Design a knuckle joint to connect two rods under a tensile load of 12 kN. The allowable stresses are 65 MPa in tension, 50 MPa in shear and 83 MPa in crushing.

b) Also design a sleeve type cotter joint for the above application, assuming the same material properties.

c) Draw neat sketches of the joints.

8+8+4

4. Design a rigid coupling to transmit 30 kW power at 980 rpm (Consider a service factor of 1.25). The bolts are made of 45C8 steel having tensile yield strength of 380 N/mm^2. The yield strength in shear and compression can be taken as 0.5 and 1.2 times the yield strength in tension. Assume that the coupling body is made from FG 250 cast iron. Specify the designed dimension through a neat sketch of the coupling. The factor of safety can be taken as 2.5.

How the design will change if a flexible shaft coupling is required for the application? Only state the changes in design steps to be followed with supporting sketches, without going through the numerical calculations for actual design dimensions.

12+8

5. Design a flat belt drive to transmit 60 kW at a belt speed of 20 m/s. The pulley diameters are 250 mm and 400 mm, and their center distance is 1 m. The allowable stress of belt material is 8 MPa and it's density is 1100 kg/m^3. The thickness to width ratio of the available belts is 0.1 and coefficient of friction between belt and CI pulleys is 0.3. Make a schematic diagram of the belt drive and specify tight side, slack side and centrifugal belt tensions. Also determine the minimum required pre-tension in belt.

12+4+4

6a) i) Draw 'load-vs-time' diagrams for reversed and repeated type fatigue loading and indicate mean and amplitude loads in the diagrams.

ii) Draw a typical S-N diagram for a steel specimen and state how such a diagram is obtained.

iii) State the difference between Soderberg line and Goodman line with the help of a fatigue diagram.

iv) How machine elements under combined fatigue loadings are designed?

v) Explain theoretical stress concentration factor and notch sensitivity factor.

b) A solid circular shaft is subjected to torsional moment that varies from 200 N-m to 500 N-m and at the same time, is subjected to bending moment that varies from 50 N-m to 150 N-m. The frequency of variation of these stresses is equal to the shaft speed. The shaft is made of plain carbon steel (σ_{yt} = 400 N/mm^2 & σ_{ut} = 550 N/mm^2). Determine the shaft diameter considering the following: Surface finish factor: 0.9, Reliability factor: 0.9, theoretical stress concentration factor: 2, notch sensitivity: 0.25 and factor of safety: 1.5.

(2+2+2+2+2) + 10

7 a) Prove that the maximum load on a preloaded bolt is given by P_i + P/(1+a), where P_i is initial tightening load, P is externally applied load and a is the ratio of stiffnesses. Draw load deflection diagram of the bolted joint in support of your derivation.

b) A 25mm thick steel bracket is to be attached to a wall with the help of six identical bolts as shown in the figure Q7(b). Select standard bolts made of suitable material for the eccentrically loaded bolted joint application.

(8+2) + 10

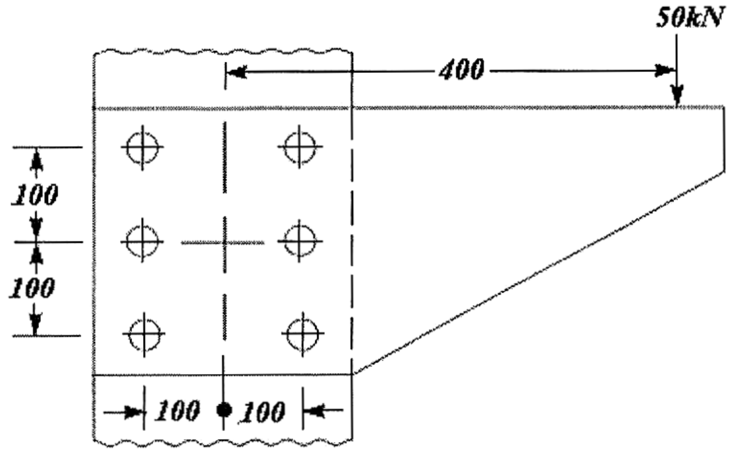


Fig. Q7(b).

8 a) In a double threaded (i.e., double action) screw jack, one end of the screw is fixed in the nut and the other end supports a load of 6 kN. The thread pitch is 9 mm, nominal diameter is 60 mm and assume thread friction co-efficient as 0.15. Draw a neat sketch of the screw jack and determine the torques required to raise and lower the load. Also calculate efficiency of the screw for lifting load.

b i) Make a comparative study between riveted and welded joints.

b ii) Draw a sketch of fillet welded joint and indicate parallel and transverse welding.

b iii) How a weld joint is specified by using welding symbols?

(3+5+2) + (4+3+3)