



MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : ME-503

DESIGN OF MACHINE ELEMENTS

Time Allotted: 3 Hours

Full Marks: 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Group – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives of the following: <http://www.makaut.com>

1×10=10

(i) When Helical Spring is subjected compression force, the stress induced in the spring is

- (a) tensile stress
(c) shear stress

- (b) compressive stress
(d) bending stress

(ii) Spring Index is

- (a) ratio of coil diameter to wire diameter.
(c) its capability of storing energy.

- (b) load required to produce unit deflection.
(d) indication of quality of spring.

(iii) The property of a material which enables it to resist fracture due to high impact load is known as

- (a) Elasticity
(c) Strength

- (b) Endurance
(d) Resilience

(iv) Two shafts A and B are made of same material. The diameter of shaft B is twice that of shaft A. The ratio of power which can be transmitted by shaft A to shaft B is <http://www.makaut.com>

- (a) 0.5

- (b) 0.25

- (c) 0.125

- (d) 0.0625

(v) In V-belt drive, belt touches

- (a) at bottom

- (b) at sides only

- (c) both at bottom and sides

- (d) could touch anywhere

- (vi) The Maximum Shear Stress theory is used for <http://www.makaut.com>
(a) brittle materials (b) ductile materials
(c) plastic materials (d) non-ferrous materials
- (vii) In a steam engine, the piston rod is usually connected to the cross-head by means of a
(a) Knuckle joints (b) Universal joint
(c) Flange coupling (d) Cotter joint
- (viii) Oldham's Coupling is used to connect two shafts which —
(a) have lateral misalignment (b) whose axes intersect at a small angle
(c) are in exact alignment (d) is the simplest type of rigid coupling
- (ix) If the tearing efficiency of a riveted joint is 50%, then ratio of diameter of rivet hole to the pitch of rivets is
(a) 0.20 (b) 0.30
(c) 0.50 (d) 0.60
- (x) In leaf spring the longest leaf is known as <http://www.makaut.com>
(a) lower leaf (b) master leaf
(c) upper leaf (d) none of these

Group – B

(Short Answer Type Questions)

Answer any three of the following questions.

5×3=15

2. It is required to design a flat key for used to connect a pulley to a 50 mm diameter shaft. The standard crosssection of the key is $14 \times 9 \text{ mm}^2$. The key is made of commercial steel ($S_{yt}=S_{yc} = 230 \text{ N/mm}^2$) and the factor of safety is 3. Determine the length of the key on the basis of shear and compression considerations, if 15 kW power at 360 rpm is transmitted through the keyed joint.
3. In belt drive, for maximum power transmission, show that one third of the maximum tension in the belt is absorbed as centrifugal tension. <http://www.makaut.com>

4. With the help of a figure, briefly explain how Goodman diagram and Soderberg diagram are used for fatigue design of a component.
5. A rotating bar of steel 45C8 ($S_{ut} = 630 \text{ N/mm}^2$) is subjected to a completely reversed bending stress. The corrected endurance limit of the bar is 315 N/mm^2 . Calculate the fatigue strength of the bar for a life of 90,000 cycles. <http://www.makaut.com>
6. Two rods are connected by means of a ~~knuckle joint~~. The axial force P acting on the rods is 25 kN. The rods and the pin are made of plain carbon steel 45C8 ($S_{yt} = 380 \text{ N/mm}^2$) and the factor of safety is 2.5. The yield strength in shear is 57.7% of the yield strength in tension. Calculate
- the diameter of the rods and d ,
 - the diameter of the pin d

Group - C

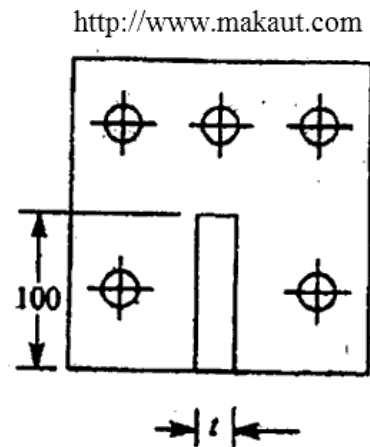
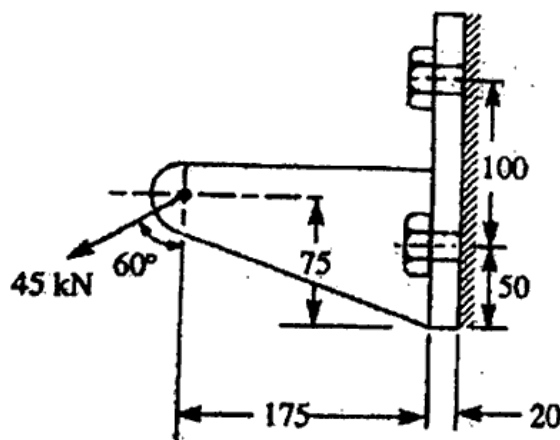
(Long Answer Type Questions)

Answer any three of the following questions.

15×3=45

7. A hot rolled steel shaft subjected to bending moment that varies from +500 N-m to -150 N-m, and a twisting moment at the critical section varies from 350 N-m clockwise to 100 N-m anticlockwise. Determine the shaft diameter. Where ultimate strength is 560 MPa, yield strength is 340 MPa, endurance limit is 280 MPa. Load correction factor for variable twisting moment is 0.6 and for variable bending moment is 0.9. Size correction factor is 0.85, surface correction factor is 0.87. Fatigue stress concentration factor is 1.42. Consider 90% reliability and chose the reliability factor accordingly.
8. Design a cotter joint to support a load varying from 30 kN in tension to 30 kN in compression. The material used is carbon steel for which the following allowable stresses may be used. The load is applied statically. <http://www.makaut.com>
- Tensile = Compressive stress = 50 MPa; Shear stress = 35 MPa and Crushing stress = 90 MPa
9. (a) What is an axle? How does it differ from a shaft?
- (b) An overhung shaft carries a pulley of 1000 mm diameter, whose centre is 250 mm from the centre of the nearest bearing. The weight of the pulley is 600N and the angle of lap of the belt may be assumed as 180° . The pulley is driven by a motor, placed below it at an angle of 45° . If the permissible tension in a belt is 2500N and coefficient of friction is 0.3, determine the size of the shaft. Assume the permissible shear stress in the shaft material as 50 MPa. Take Shock and Fatigue factor in torsion and bending as 2 and 1.5 respectively. <http://www.makaut.com> 3+12=15

10. Design a rigid type of flange coupling to connect two shafts. The input shaft transmits 37.5 KW at 180 rpm through the coupling. The service factor is 1.5 for the application. Design torque is 1.5 times the rated torque. Select suitable materials for various parts of the coupling. <http://www.makaut.com>
11. A bracket is fixed to a vertical steel column by means of five standard bolts as shown in the fig. Assume safe working stresses of 70 MPa in tension and 50 MPa in shear.
- Determine
- Diameter of the fixing bolts and
 - Thickness of the arm of the bracket.



All dimensions in mm.