# MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

## AUE-503

### DESIGN OF MACHINE ELEMENT

Time Allotted: 3 Hours                                    Full Marks: 70

*The questions are of equal value.*
*The figures in the margin indicate full marks.*
*Candidates are required to give their answers in their own words as far as practicable.*
*All symbols are of usual significance.*

## GROUP A
### (Multiple Choice Type Questions)

1.    Answer *all* questions.                                    10×1 = 10

(i) The energy stored in a body when strained within elastic limit is known as

(A) resilience                          (B) proof resilience

(C) strain energy                       (D) impact energy

(ii) In a unilateral system of tolerance, the tolerance is allowed on

(A) one side of the actual size         (B) one side of the nominal size

(C) both sides of the actual size       (D) both sides of the nominal size

(iii) The design of shafts made of brittle materials is based on

(A) Guest's Theory                      (B) Rankine's Theory

(C) St. Venant's Theory                 (D) Von Mises Theory

(iv) When a helical compression spring is subjected to an axial compressive load, the stress induced in the wire is

(A) tensile stress                      (B) compressive stress

(C) shear stress                        (D) bending stress

(v) In a leaf springs, the longest leaf is known as

(A) lower leaf        (B) master leaf    (C) upper leaf       (D) none of these

(vi) The power transmitted by means of a belt depends on

(A) velocity of belt

(B) tension under which the belt is placed on pulley

(C) arc of contact between the belt and the smaller pulley

(D) all of these

(vii) The parallel fillet welded joints is designed for

(A) tensile strength                    (B) compressive strength

(C) bending strength                    (D) shear strength

(viii) Oldham coupling is used to connect two shafts

(A) which are perfectly aligned

(B) which are not in exact alignment

(C) which have lateral misalignment

(D) whose axes intersect at a small angle

(ix) The objective of caulking in a riveted joint is to make the joint

(A) free from corrosion                 (B) stronger in tension

(C) free from stresses                  (D) leak-proof

(x) A keyway lowers

(A) the strength of the shaft

(B) the rigidity of the shaft

(C) both the strength and rigidity of the shaft

(D) the ductility of the material of the shaft

## GROUP B
### (Short Answer Type Questions)

Answer any *three* questions.                                    3×5 = 15

2.    A 45 mm diameter shaft is made of steel with a yield strength of 100 MPa. A parallel key of size 14 mm wide and 9 mm thick made of steel with a yield strength of 170 MPa is to be used. Find the required length of key, if the shaft is loaded to transmit the maximum permissible torque.

3. Explain the design process when the shaft is subjected to combined twisting moment and bending moment.

4. Find the diameter of a solid steel shaft to transmit 20 kW at 200 r.p.m. The ultimate shear stress for the steel may be taken as 360 MPa and a factor of safety as 8. If a hollow shaft is to be used in place of the solid shaft, find the inside and outside diameter when the ratio of inside to outside diameters is 0.5.

5. A plate 100 mm wide and 12.5 mm thick is to be welded to another plate by means of parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of the weld so that the maximum stress does not exceed 56 MPa. Consider the joint first under static loading and then under fatigue loading.

6. A leather belt 9 mm × 250 mm is used to drive a cast iron pulley 900 mm in diameter at 336 r.p.m. If the active arc on smaller pulley is 120° and the stress in tight side is 2 MPa. Find the power capacity of the belt if density of the belt = 980 kg/m$^3$ and the co-efficient of friction of leather on cast iron is 0.35.

## GROUP C
### (Long Answer Type Questions)
Answer any *three* questions.      3×15 = 45

7. Design and draw a cotter joint to support a load varying from 30 kN in compression to 30 kN in tension. The material used is carbon steel for which the following allowable stresses may be used. The load is applied statically. Tensile stress = compressive stress = 150 MPa; shear stress = 115 MPa and crushing stress = 270 MPa. Take factor of safety = 3. Draw the free hand drawing and give all the dimensions.   15

8. A circular bar of 500 mm length is supported freely at its two ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20 kN and a maximum value of 50 kN. Determine the diameter of bar by taking a factor of safety of 1.5, size effect of 0.85, surface finish factor of 0.9. The material properties of bar are given by: ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa.   15

9. Design a double riveted butt joint with two cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm$^2$. Assume joint efficiency as 75%, allowable tensile stress in the plate 90 MPa; compressive stress 140 MPa; and shear stress in the rivet 56 MPa.   15

10. It is required to design a rigid type of flange coupling to connect two shafts. The input shaft transmits 37.5 kW power at 180 r.p.m. to the output shaft through the coupling. The service factor for the application is 1.5 that is the design torque is 1.5 times of rated torque. Shear stress for shaft is 76 MPa, shear stress for key and bolts is 80 MPa, crushing stress for bolt and key is 240 MPa, shear stress for flanges 16.67 MPa. Draw a neat sketch of the coupling.   15

11. Design a knuckle joint to transmit 150 kN. The design stresses may be taken as 75 MPa in tension, 60 MPa in shear and 150 MPa in compression.   15