ENGINEERING & MANAGEMENT EXAMINATIONS, DECEMBER – 2006
DESIGN OF MACHINE ELEMENTS
SEMESTER – 5

Time : 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.

Note : Answer Question No. *1* and any *four* from the rest.

1.   Choose the correct alternatives (any *ten*) :   10 × 1 = 10

    i)   A stud

        a)   has a head on one end and a nut fitted to the other

        b)   has head at one end and other end is fitted into a tapped hole in the other part to be joined

        c)   has both ends threaded

        d)   has pointed threads

        e)   requires locking nut.

    ii)   The function of a washer is to

        a)   provide cushioning effect

        b)   provide bearing area

        c)   absorb shocks and vibrations

        d)   provide smooth surface in place of rough surface

        e)   act as a locking device.

    iii)   The designation M 33 × 2 of a bolt means

        a)   metric threads of 33 nos. in 2 cm

        b)   metric threads with cross-section of 33 mm ^{2}

        c)   metric threads of 33 mm pitch diameter and 2 mm pitch

        d)   bolt of 33 mm nominal diameter having 2 mm pitch

        e)   none of these

iv) If the tearing efficiency of a riveted joint is 75%, then the ratio of diameter of rivet to the pitch is equal to
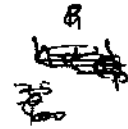
    a)   0·2   b)   0·25

    c)   0·50   d)   0·60

    e)   0·75.

v) A key capable of tilting in a recess milled out in a shift is known as

    a)   wood-ruff key   b)   feather key

    c)   flat saddle key   d)   gib head key

    e)   hollow saddle key.

vi) If α is the helix angle of threads and ϕ is the angle of friction, then the lifting screw will be self-locking when α

    a) $= \phi$ b) $< \phi$

    c) $> \phi$ d) $= 2\phi$

    e)   there is no such correlation.

vii) The Wahl stress factor K for springs of spring index

    C = D/d = (Mean dia. of coil / wire dia.) is given by

    a) $(4C - 1) / (4C - 2) + 0·615/C$

    b) $(C - 4) / (4C - 4) + 0·615/C$

    c) $(4C - 4) / (4C - 1) + 0·615/C$

    d) $(4C - 1) / (4C - 4) + 0·615/C$

    e) $(4C - 1) / (C - 4) + 0·615/C.$

viii) In replacing the V-belts, a complete set of new belts is used instead of replacing a single damaged belt because

    a)   belts are available in set

    b)   only one belt can't be fitted with other used belts

    c)   the new belt would carry more than its share and would have a short life

    d)   such an arrangement would cause heavy vibration

    e)   one belt can't be replaced.

ix) According to Guest theory, the failure occurs at a point in a member when the maximum shear stress in a bi-axial stress system reaches the shear stress at elastic limit in simple tension test. Guest theory is applicable to

    a)   tough materials   b)   plastic materials

    c)   ductile materials   d)   brittle materials.

x) The bolts in a rigid flanged coupling connecting two shafts transmitting power are subjected to

    a)   shear force and bending moment

    b)   axial force

    c)   torsion

    d)   torsion and bending moment.

xi) The permissible stress in a fillet weld is 100 N/mm^2. The fillet weld has equal leg length of 15 mm each. The allowable shear load on weldment per cm length of weld is

    a)   22·5 kN   b)   15·0 kN

    c)   10·6 kN   d)   7·5 kN.

xii) To ensure self-locking in a screw jack, it is essential that helix angle is

    a)   larger than friction angle   b)   smaller than friction angle

    c)   equal to friction angle   d)   none of these.

2.   a)   Show by neat sketches the various ways in which a riveted joint may fail.   3

    b)   A bracket is riveted to a column by 6 rivets of equal size as shown in Fig. 1. It carries a load of 100 kN at a distance of 250 mm from the column. If the maximum shear stress in the rivet is limited to 63 N/mm^2, find the diameter of the rivet.   12

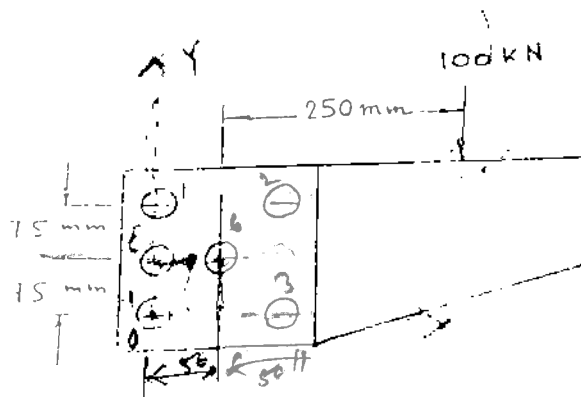Fig. 1

3. A crane hook carries a load of 90 kN, as shown in Fig. 2. The section at A-A is trapezoidal whose dimensions are shown in the figure. Find the stress in the inner and outer fibres at the given section. 15

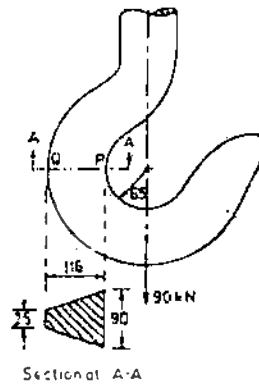Fig. 2. All dimensions are in mm.

4. A welded connection of steel plates is shown in Fig. 3. It is subjected to an eccentric force of 50 kN. Determine the size of the weld; if the permissible shear stress in the weld is not to exceed 70 N/mm². 15
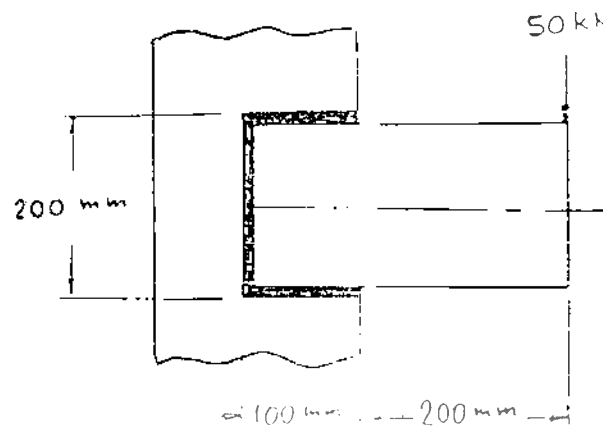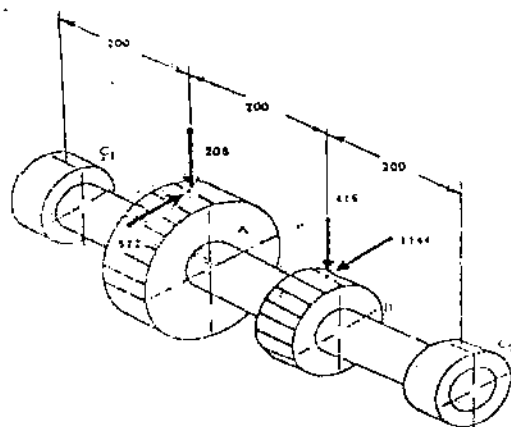
5. A safety valve of 60 mm diameter is to blow off at a pressure of 1·2 N/mm². It is held on its seat by a close-coiled helical spring. The maximum lift of the valve is 10 mm. Design a suitable compression spring of spring index 5 and providing an initial compression of 35 mm. The maximum shear stress in the material of the wire is limited to 500 N/mm². The modulus of rigidity for the spring material is 80 N/mm². Calculate

    i) Diameter of the spring wire

    ii) Mean coil diameter,

    iii) Number of active turns, and

    iv) Pitch of the coil.

    Take the Wahl's factor, $K = \{(4C - 1) / (4C - 4)\} + 0·615/C$, where C is the spring index.   15

6. An intermediate shaft of a gearbox, supporting two spur gears A and B mounted between two bearings C_1 and C_2, is shown in Fig. 4. The pitch circle diameters of gears A and B are 500 mm and 250 mm respectively. The shaft is made of alloy steel 40MnCr, (f_{ut} = 620 and f_{yt} = 480 N/mm²). The factors k_b and k_t of the A.S.M.E code are 2 and 1·5 respectively. The gears are keyed to the shaft. Determine the shaft **diameter using the A.S.M.E code.**

    If the permissible angle of twist for the shaft is 0·25° per metre length and the modulus of rigidity is 79300 N/mm², determine the shaft diameter on the basis of torsional rigidity also.   15

Fig. 4 : All dimensions are in mm.

7. Design a circular flanged pipe joint for a cast iron pipe with internal diameter 200 mm subjected to a fluid pressure of 0·7 N/mm². The flange is connected by means of eight bolts. The pitch circle diameter of the bolts is 290 mm. Take the allowable tensile stress in the pipe material as 14 N/mm² and in the bolts as 60 N/mm².   15