KONGUNADU COLLEGE OF ENGINEERING AND TECHNOLOGY

Namakkal - Trichy Main Road, Thottiam, Trichy

DEPARTMENT OF MECHANICAL ENGINEERING

ME8593 – DESIGN OF MACHINE ELEMENTS

QUESTION BANK

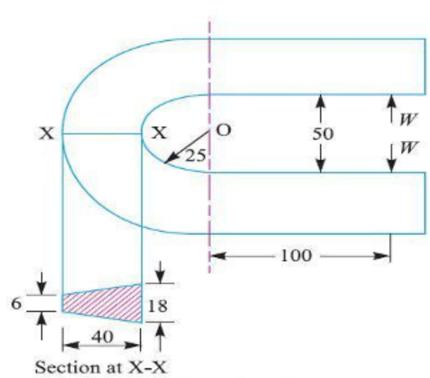
UNIT -1 STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS

PART-A

1. What is 'Adaptive design and Optimum design? (Dec 2007, 2011, 2012)
2. List some factors that influence machine design. (Dec 2010)
3. Describe material properties hardness stiffness and resilience. (Apr 2009, Nov 2009, Dec 2013)
4. What is interchangeable manufacture?
5. What are unilateral and bilateral tolerances?(May 2013)
6. Differentiate between hardness and toughness of materials. (May 2014)
7. List at least two methods to improve the fatigue strength. (Nov 2008)
8. Determine the force required to punch a hole of 20mm diameter in a 5mm thick plate with ultimate shear strength of 250MPa. (Nov 2014)
9. State the different between straight and curved beams. (Dec 2012)
10. Give some methods of reducing stress concentration.(Dec 2010)
11. What are the factors that govern selection of materials while designing a machine component? (Dec 2010)
12. Define stress concentration and stress concentration factor.(Apr 2009, May 2012, 2014)
13. Explain notch sensitivity. State the relation between stress concentration factor, fatigue stress concentration factor and notch sensitivity.
14. What are the methods used to improve fatigue strength? (Dec 2013)
15. State Rankine theory of failure and its limitations.
16. Define modulus of resilience and proof resilience. (April 2017)
17. What is Gerber Theory?
18. Define unilateral and bilateral tolerance.
19. Define unilateral and bilateral tolerance.
20. What are the commonly used fits according to Indian standards?

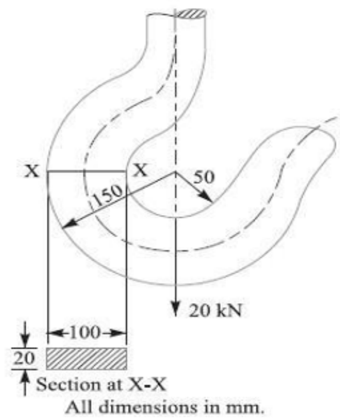
PART-B

1. The frame of a punch press is shown in Fig.. Find the stresses at the inner and outer surface at section X-X of the frame, if W = 5000 N.(Apr/May-14)



All dimensions in mm.

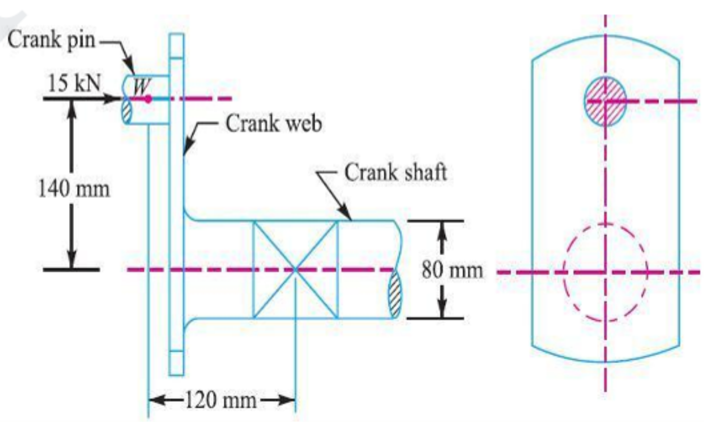
2 The crank hook carries a load of 20 KN as shown in FIG..This section at X-X is rectangular whose horizontal side is 100mm. Find the stresses in the inner and outer fibers at the given section



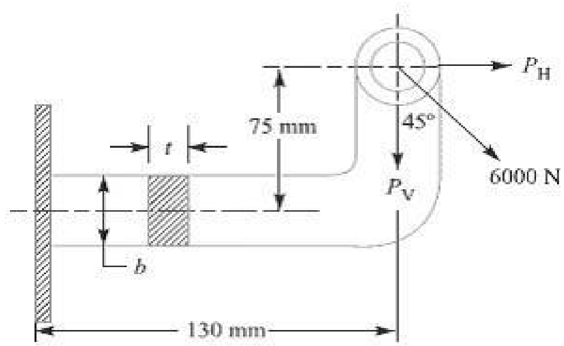
3. The load on a bolt consists of an axial pull of 10kN together with a transverse shear force of 5Kn. Find the diameter of bolt required according to 1. Maximum principal stress theory; 2. Maximum shear stress theory; 3. Maximum principal strain theory; 4. Maximum strain energy theory and 5. Maximum distortion energy theory.

4. A bar of circular cross section is subjected to alternating tensile forces varying from a minimum of 200KN to a maximum of 500KN. It is to be manufactured of material with an ultimate tensile strength of 900Mpa and an endurance limit of 700Mpa. Determine the diameter of bar using safety factors of 3.5 related to ultimate tensile strength and 4 related to endurance limit and stress concentration factor of 1.65 for a fatigue load. Use Goodman straight line as basis for design.

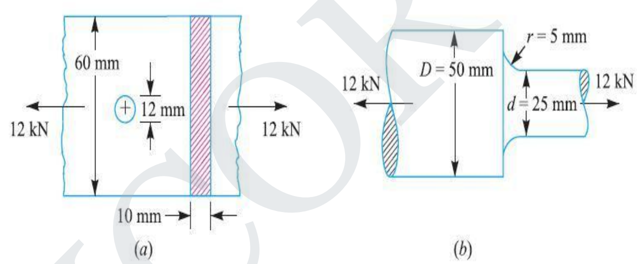
5. An overhang crank with pin and shaft is shown in Fig. A tangential load of 15 kN acts on the crank pin. Determine the maximum principal stress and the maximum shear stress at the centre of the crankshaft bearing.



6. A mild steel bracket as shown in fig.is subjected to a pull of 6000N acting at 45^0 to its horizontal axis. The bracket has a rectangular section whose depth is twice the thickness. Find the cross sectional dimensions of the bracket, if the permissible stress in the material of the bracket is limited to 60 MPa.(May-15)



7. Find the maximum stress induced in the following cases taking stress concentration into account (i) A rectangular plate 60 mm × 10 mm with a hole 12 diameter as shown in Fig. (a) and subjected to a tensile load of 12 kN. (ii) A stepped shaft as shown in Fig. (b) and carrying a tensile load of 12 kN.



8. A leaf spring in an automobile is subjected to cyclic stresses. The average stress = 150 MPa; variable stress = 500 MPa; ultimate stress = 630 MPa; yield point stress = 350 MPa and endurance limit = 150 MPa. Estimate, under what factor of safety the spring is working, by Goodman and Soderberg formulae.

9. A steel connecting rod is subjected to a completely reversed axial load of 160 kN. Suggest the suitable diameter of the rod using a factor of safety 2. The ultimate tensile strength of the material is 1100 MPa, and yield strength 930 MPa. Neglect column action and the effect of stress concentration.

10. A pulley is keyed to a shaft midway between two anti-friction bearings. The bending moment at the pulley varies from – 170 N-m to 510 N-m and the torsional moment in the shaft varies from 55 N-m to 165 N-m. The frequency of the variation of the loads is the same as the shaft speed. The shaft is made of cold drawn steel having an ultimate strength of 540 MPa and a yield strength of 400 MPa. Determine the required diameter for an indefinite life. The stress concentration factor for the keyway in bending and torsion may be taken as 1.6 and 1.3 respectively. The factor of safety is 1.5. Take size factor = 0.85 and surface finish factor = 0.88.

11. A cantilever of span 250mm and 50mm diameter carries a vertical downward load of 3KN at free and along with a torque of 1000N-m and an axial pull of 15KN.Calculate the maximum normal stresses at the top and bottom face of the fixed end. (May-11)

12. A circular cross section C45 steel member is subjected to an axial load that varies from-1000N to +2500N and to a torsional moment that varies from 0 to +500N-m. Assume factor of safety as 1.5 and stress concentration factor is 1.5. Calculate the diameter of the member for infinite life.(Dec-13)

13. A horizontal nickel steel shaft rests on two bearings, A at the left and B at the right end carries two gears C and D located at the distances of 250mm and 400mm respectively from the centre line of the left and right bearings. The pitch diameter of the gear C is 600mm and that of gear D is 200mm.The distance between the centre line of the bearings is 2400mm.The shaft is transmits 20KW at 120rpm.The Power is delivered to the shaft at gear C and is taken out at gear D. In such a manner that the tooth pressure Ftc of the gear C and Ftd Of the gear D act its vertically downward. Find the diameter of the shaft, if the working stress is 100Mpa in tension and 56Mpa in shear. The Gear C And D Weigh 950N And 350N .The combined shock and fatigue factors for bending and torsion may be taken as 1.5and 1.2 (May-11)

UNIT-II SHAFTS AND COUPLINGS

PART-A

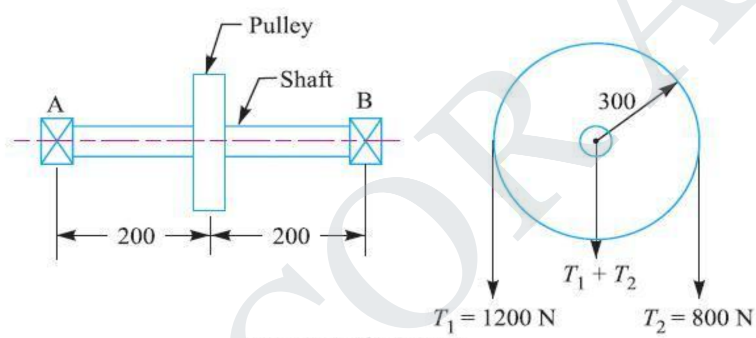
1. Classify keys with its applications? (May 2012)
2. Discuss the forces on key? (Dec 2012, Dec 2014)
3. What are the various stresses induced in shafts? (May 2014)
4. Name any two of the rigid coupling? (May 2014)
5. What is the difference between rigid and flexible coupling? (May 2013, May 2016)
6. How is the strength of a shaft affected by the keyway? (May2014)\
7. What is the main use of woodruff key? (Nov 2013)
8. A shaft of 70 mm long is subjected to shear stress of 40 Mpa and has an angle of twist equal to 0.017 radian. Determine the diameter of the shaft. Take G= 80 Mpa? (Nov 2013)
9. Why a hollow shaft has greater strength and stiffness than solid shaft of equal weight? (Nov 2012)
10. Indicate the effects of providing key ways in the shaft? (Nov 2010)
11. What do you mean by stiffness and rigidity with reference to shafts? (Dec 2010)
12. Differentiate between keys and splines? (Nov 2011)
13. Under what circumstances flexible couplings are used? (Nov 2012)
14. How is flexibility achieved in flexible coupling? (Nov 2010)
15. Suggest suitable couplings for, shafts with parallel misalignment, shafts with angular misalignment of 100, shafts in perfect alignment?
16. Define equivalent torsional moment of a shaft. (April 2017)
17. What do you understand by torsional rigidity and lateral rigidity?
18. What is the effect of keyway cut into the shaft?
19. Sketch a protective type flange coupling and indicate there on its leading dimensions for shaft size of ‘*d*’.

20. What are flexible couplings and what are their applications? Illustrate your answer with suitable examples and sketches.

PART-B

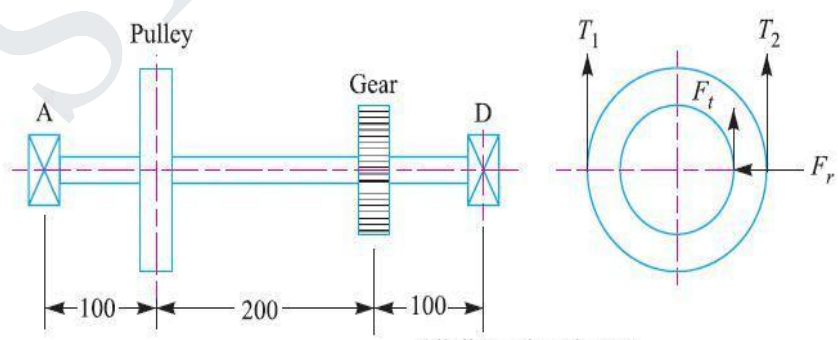
1. A hollow steel shaft transmits 600 kW at 500 r.p.m. The maximum shear stress is 62.4 MPa. Find the outside and inside diameter of the shaft, if the outer diameter is twice of inside diameter, assuming that the maximum torque is 20% greater than the mean torque.
2. Two 400 mm diameter pulleys are keyed to a simply supported shaft 500 mm apart. Each pulley is 100 mm from its support and has horizontal belts, tension ratio being 2.5. If the shear stress is to be limited to 80 MPa while transmitting 45 kW at 900 r.p.m., find the shaft diameter if it is to be used for the input-output belts being on the same or opposite sides.

3. Fig. shows a shaft from a hand-operated machine. The frictional torque in the journal bearings at *A* and *B* is 15 N-m each. Find the diameter (*d*) of the shaft (on which the pulley is mounted) using maximum distortion energy criterion. The shaft material is 40 C 8 steel for which the yield stress in tension is 380 MPa and the factor of safety is 1.5.



All dimensions in mm.

4. A shaft made of steel receives 7.5 kW power at 1500 r.p.m. A pulley mounted on the shaft as shown in Fig. has ratio of belt tensions 4. The gear forces are as follows: F_t = 1590 N; F_r = 580 N. Design the shaft diameter by maximum shear stress theory. The shaft material has the following properties: Ultimate tensile strength = 720 MPa; Yield strength = 380 MPa; Factor of safety = 1.5.



All dimensions in mm.

5. The shaft of an axial flow rotary compressor is subjected to a maximum torque of 2000 N-m and a maximum bending moment of 4000 N-m. The combined shock and fatigue factor in torsion is 1.5 and that in bending is 2. Design the diameter of the shaft, if the shear stress in the shaft is 50 MPa. Design a hollow shaft for the above compressor taking the ratio of outer diameter to the inner diameter as 2. What is the percentage saving in material ? Also compare

6. A steel shaft has a diameter of 25 mm. The shaft rotates at a speed of 600 r.p.m. and transmits 30 kW through a gear. The tensile and yield strength of the material of shaft are 650 MPa and 353 MPa respectively. Taking a factor of safety 3, select a suitable key for the gear. Assume that the key and shaft are made of the same material.
7. Design a rigid flange coupling to transmit a torque of 250 N-m between two coaxial shafts. The shaft is made of alloy steel, flanges out of cast iron and bolts out of steel. Four bolts are used to couple the flanges. The shafts are keyed to the flange hub. The permissible stresses are given below: Shear stress on shaft =100 MPa Bearing or crushing stress on shaft =250 MPa Shear stress on keys =100 MPa Bearing stress on keys =250 MPa Shearing stress on cast iron =200 MPa Shear stress on bolts =100 MPa After designing the various elements, make a neat sketch of the assembly indicating the important dimensions. The stresses developed in the various members may be checked if thumb rules are used for fixing the dimensions.(May-15)

8. Two shafts made of plain carbon steel are connected by a rigid protective type flange coupling. The shafts are running at 500 r.p.m. and transmit 25 kW power. Design the coupling completely for overload capacity 25 per cent in excess of mean transmitted torque capacity. Assume the following permissible stresses for the coupling components : Shaft — Permissible tensile stress = 60 MPa; Permissible shear stress = 35 MPa Keys — Rectangular formed end sunk key having permissible compressive strength = 60 MPa, Bolts — Six numbers made of steel having permissible shear stress = 28 MPa Flanges — Cast iron having permissible shear stress = 12 MPa Draw two views of the coupling you have designed.

9. A flanged protective type coupling is required to transmit 50 kW at 2000 r.p.m.. Find: (a) Shaft diameters if the driving shaft is hollow with di / $d0$ = 0.6 and driven shaft is a solid shaft. Take τ = 100 MPa.(b). Diameter of bolts, if the coupling uses four bolts. Take $\sigma c = \sigma t$ = 70 MPa and τ = 25 MPa. Assume pitch circle diameter as about 3 times the outside diameter of the hollow shaft.(*c*) Thickness of the flange and diameter of the hub. Assume σc = 100 MPa and τ = 125 MPa.(d). Make a neat free hand sketch of the assembled coupling showing a longitudinal sectional elevation with the main dimensions. The other dimensions may be assumed suitably.

10. Design a bushed-pin type of flexible coupling to connect a pump shaft to a motor shaft transmitting 32 kW at 960 r.p.m. The overall torque is 20 percent more than mean torque. The material properties are as follows : (a) The allowable shear and crushing stress for shaft and key material is 40 MPa and 80 MPa respectively. (b) The allowable shear stress for cast iron is 15 MPa. (c) The allowable bearing pressure for rubber bush is 0.8 N/mm2. (d) The material of the pin is same as that of shaft and key. Draw neat sketch of the coupling.

UNIT –III TEMPORARY AND PERMANENT JOINTS

PART-A

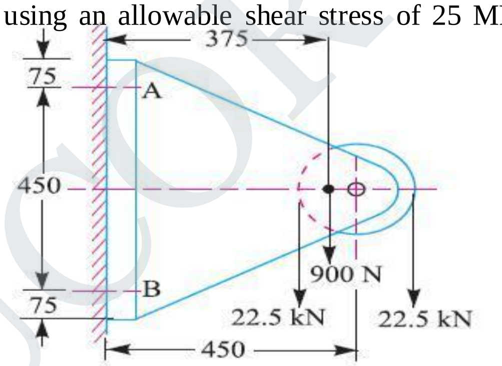
1. How is a bolt designated? Give example. (Dec 2006,Apr 2009)
2. Why are ACME threads preferred over square thread for power screw?(Nov 2014)
3. What are the various initial stresses developed due to screwing up in bolted joints? (Dec 2010)

4. Under what force, the big end bolts and caps are designed.(Dec 2011)
5. What is gib? Why it is provided in a cotter joint?(Dec 2013)

6. What are the different types of cotter joints? (May 2014)
7. Why are welded joints preferred over riveted joints? (Nov 2003, Apr2008, Apr 2009)
8. What is the minimum size for fillet weld? If the required weld size from strength consideration is too small how will you fulfill the condition of minimum weld size? (Nov 2008)
9. Name the possible modes of failure of riveting joint. (Nov 2008, Dec 2012,May 2012)
10. What is meant by the efficiency of the riveted joint? (Dec 2010)
11. What are the reason of replacing riveted joint by welded joint in modern equipment.(Dec 2010)
12. State the two types of eccentric welded connection (Dec 2013)
13. What is caulking and fullering?
14. Differentiate with a neat sketch the fillet welds subjected to parallel loading and transverse loading. (Apr-04, May-14)
15. Write Rayleigh-Ritz equation to determine the critical speed of shaft subjected to point loads. .(Apr/May-18)

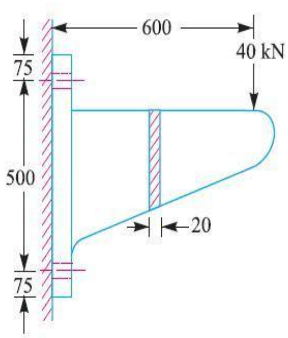
PART-B

1. A pulley bracket, as shown in Fig, is supported by 4 bolts, two at *A-A* and two at *B-B*. Determine the size of bolts using an allowable shear stress of 25 MPa for the material of the bolts.



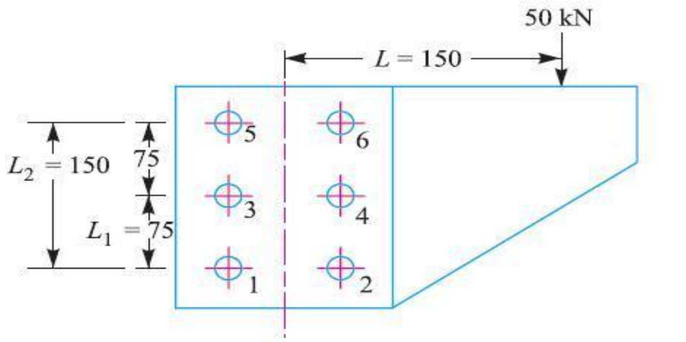
All dimensions in mm.

2. A wall bracket, as shown in Fig, is fixed to a wall by means of four bolts. Find the size of the bolts and the width of bracket. The safe stress in tension for the bolt and bracket may be assumed as 70 MPa.



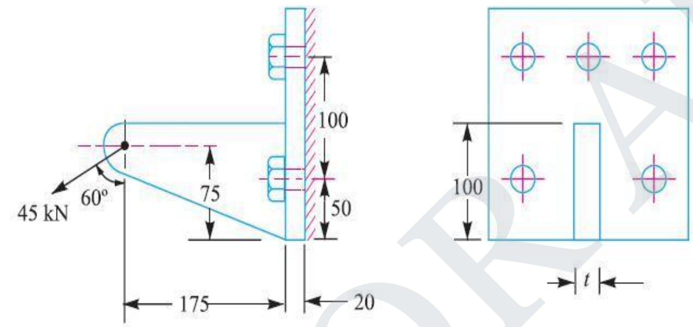
All dimensions in mm.

3. A bracket is bolted to a column by 6 bolts of equal size as shown in Fig. It carries a load of 50 kN at a distance of 150 mm from the centre of column. If the maximum stress in the bolts is to be limited to 150 MPa, determine the diameter of bolt.



All dimensions in mm.

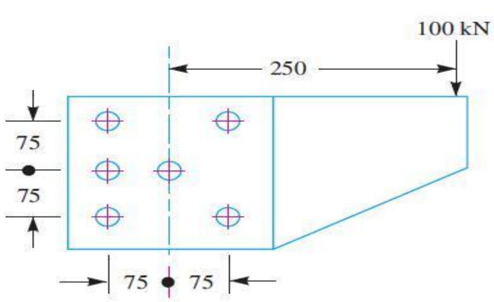
4. A bracket, as shown in Fig, is fixed to a vertical steel column by means of five standard bolts. Determine : (*a*) The diameter of the fixing bolts, and (*b*) The thickness of the arm of the bracket. Assume safe working stresses of 70 MPa in tension and 50 MPa in shear.



All dimensions in mm.

5. Design a cotter joint to connect two mild steel rods for a pull of 30 kN. The maximum permissible stresses are 55 MPa in tension ; 40 MPa in shear and 70 MPa in crushing. Draw a neat sketch of the joint designed.

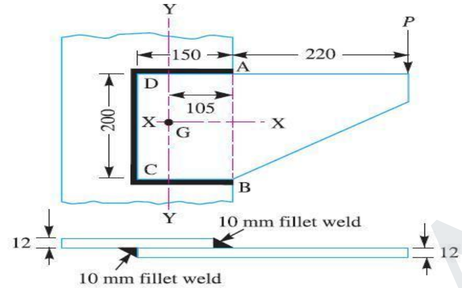
6. Design a knuckle joint to connect two mild steel bars under a tensile load of 25 kN. The allowable stresses are 65 MPa in tension, 50 MPa in shear and 83 MPa in crushing.
7. A bracket is riveted to a columm by 6 rivets of equal size as shown in Fig. It carries a load of 100 kN at a distance of 250 mm from the column. If the maximum shear stress in the rivet is limited to 63 MPa, find the diameter of the rivet.



All dimensions in mm.

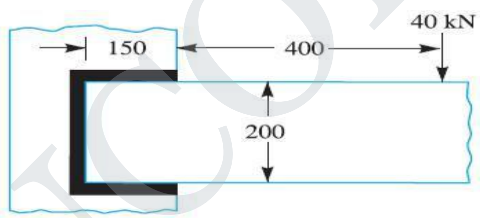
8. A triple riveted butt joint with equal double cover plates (zig-zag riveting) is used for the longitudinal joint of a Lancashire boiler of 2.5 m internal diameter. The working steam pressure is 1.12 N/mm2 and the efficiency of the joint is 85 per cent. Calculate the plate thickness for mild steel of 460 MPa ultimate tensile strength. Assume ratio of tensile to shear stresses as 7/6 and factor of safety 4. The resistance of the rivets in double shear is to be taken as 1.875 times that of single shear. Design a suitable circumferential joint also.

9. A bracket is welded to the side of a column and carries a vertical load *P*, as shown in Fig.. Evaluate *P* so that the maximum shear stress in the 10 mm fillet welds is 80 MPa.



All dimensions in mm.

10. A bracket, as shown in Fig, carries a load of 40 kN. Calculate the size of weld, if the allowable shear stress is not to exceed 80 MPa.



All dimensions in mm.

UNIT-IV ENERGY STORING ELEMENTS AND ENGINE COMPONENTS

PART-A

1. Why springs are used in the machine? (Dec 2010)
2. State any two functions of springs. (Dec 2006)
3. What is surge in springs? (May 2013)
4. What is meant by semi elliptical leaf spring? (May 2014)
5. What is the purpose of flywheel that is used in an IC engine? (Dec 2013)
6. How does the function of flywheel differ from that of governor? (Dec 2012)
7. Define the co-efficient of fluctuation of speed in case of flywheel. (Nov 2014)
8. Under what circumstances Bellevellie springs used? (Dec 2010)
9. Distinguish between close coiled and open coiled springs. (Nov 2014) Open coiled spring;
10. Mention any four types of springs. (May 2012)
11. Why leaf springs are made in layers instead of single plate? (Dec 2010)

12. Define spring Index and stiffness. (DEC 2011)
13. What are different styles of end for helical compression spring? (Nov 2009)
14. Why piston end of a connecting rod kept smaller than the crank pin end? (Dec 2010)
15. At what angle of the crank the twisting moment is maximum in the crankshaft? (Dec 2011)
16. What are the forces acting on connecting rod? (April 2017)

PART-B

1. Design a compression helical spring to carry a load of 500 N with a deflection of 25 mm. The spring index may be taken as 8. Assume the following values for the spring material: Permissible shear stress = 350 MPa Modulus of rigidity = 84 kN/mm^2 Design a helical spring for a spring loaded safety valve for the following conditions : Operating pressure = 1 N/mm2Maximum pressure when the valve blows off freely = 1.075 N/mm2 Maximum lift of the valve when the pressure is 1.075 N/mm^2 = 6 mm Diameter of valve seat = 100 mm Maximum shear stress = 400 MPa Modulus of rigidity = 86 kN/mm^2 Spring index = 5.5
2. A vertical spring loaded valve is required for a compressed air receiver. The valve is to start opening at a pressure of 1 N/mm^2 gauge and must be fully open with a lift of 4 mm at a pressure of 1.2 N/mm^2 gauge. The diameter of the port is 25 mm. assume the allowable shear stress in steel as 480 MPa and shear modulus as 80 kN/mm^2. Design a suitable close coiled round section helical spring having squared ground ends. Also specify initial compression and free length of the spring.
3. A semi-elliptical laminated vehicle spring to carry a load of 6000 N is to consist of seven leaves 65 mm wide, two of the leaves extending the full length of the spring. The spring is to be 1.1 m in length and attached to the axle by two U-bolts 80 mm apart. The bolts hold the central portion of the spring so rigidly that they may be considered equivalent to a band having a width equal to the distance between the bolts. Assume a design stress for spring material as 350 MPa. Determine : 1. Thickness of leaves, 2. Deflection of spring, 3. Diameter of eye, 4. Length of leaves, and 5. Radius to which leaves should be initially bent. Sketch the semi-elliptical leaf-spring arrangement. The standard thickness of leaves are : 5, 6, 6.5, 7, 7.5, 8, 9, 10, 11 etc. in mm.(May-16)
4. A railway wagon weighing 50 kN and moving with a speed of 8 km per hour has to be stopped by four buffer springs in which the maximum compression allowed is 220 mm. Find the number of turns in each spring of mean diameter 150 mm. The diameter of spring wire is 25 mm. Take G = 84 kN/mm2.
5. A semi-elliptical spring has ten leaves in all, with the two full length leaves extending 625 mm. It is 62.5 mm wide and 6.25 mm thick. Design a helical spring with mean diameter of coil 100 mm which will have approximately the same induced stress and deflection for any load. The Young's modulus for the material of the semi-elliptical spring may be taken as 200 kN/mm2 and modulus of rigidity for the material of helical spring is 80 kN/mm^2.

6. Design a leaf spring for the following specifications : Total load = 140 kN ; Number of springs supporting the load = 4 ; Maximum number of leaves = 10; Span of the spring = 1000 mm ; Permissible deflection = 80 mm. Take Young's modulus, E = 200 kN/mm2 and allowable stress in spring material as 600 MPa.

7. Design a cast iron flywheel for a four stroke cycle engine to develop 110 kW at 150 r.p.m. The work done in the power stroke is 1.3 times the average work done during the whole cycle. Take the mean diameter of the flywheel as 3 metres. The total fluctuation of speed is limited to 5 per cent of the mean speed. The material density is 7250 kg / m3. The permissible shear stress for the shaft material is 40 MPa and flexural stress for the arms of the flywheel is 20 MPa.

8. A punching press is required to punch 40 mm diameter holes in a plate of 15 mm thickness at the rate of 30 holes per minute. It requires 6 N-m of energy per mm^2 of sheared area. Determine the moment of inertia of the flywheel if the punching takes one-tenth of a second and the r.p.m. of the flywheel varies from 160 to 140.

9. Design completely the flywheel, shaft and the key for securing the flywheel to the shaft, for a punching machine having a capacity of producing 30 holes of 20 mm diameter per minute in steel plate 16 mm thickness. The ultimate shear stress for the material of the plate is 360 MPa. The actual punching operation estimated to last for a period of 36º rotation of the punching machine crankshaft. This crank shaft is powered by a flywheel shaft through a reduction gearing having a ratio 1 : 8. Assume that the mechanical efficiency of the punching machine is 80% and during the actual punching operation the flywheel speed is reduced by a maximum of 10%. The diameter of flywheel is restricted to 0.75 m due to space limitations.

UNIT-V BEARINGS

PART-A

1. How are bearings classified? (Dec 2010 & MAY 2014)
2. What is a journal bearing? List any two applications. (Nov 2006, May 2013 & May 2014)
3. Classify the sliding contact bearings according to the thickness of layer of the lubricant between the bearing and the journal.(May 2012)
4. For a journal bearing, the maximum operating temperature must be less than 80^{o}C. why?(Dec 2010)
5. What is known as self acting bearing? (NOV 2007)
6. Explain the term dynamic load carrying capacities of rolling contact bearing. (Dec 2012)
7. What are the types of radial ball bearing? (May 2012)
8. What is the application of thrust bearing? (Dec 2010)
9. What is meant by life of anti-friction bearing? (Apr 2008 & May 2013)
10. List any four advantages to rolling contact bearings over sliding contact bearings. (Apr 2009)
11. State the disadvantages of thrust ball bearing. (Apr 2009)
12. Define static capacity of bearing. (Nov 2014)
13. Explain the term dynamic load carrying capacities of rolling contact bearing. (Nov 2004)
14. What are the modes of failure of rolling contact bearing? (Dec 2010)
15. What are anti friction bearings? (April 2017)

PART-B

1. The ball bearings are to be selected for an application in which the radial load is 2000 N during 90 per cent of the time and 8000 N during the remaining 10 per cent. The shaft is to rotate at 150 r.p.m. Determine the minimum value of the basic dynamic load rating for 5000 hours of operation with not more than 10 per cent failures.

2. A single row deep groove ball bearing operating at 2000 r.p.m. is acted by a 10 kN radial load and 8 kN thrust load. The bearing is subjected to a light shock load and the outer ring is rotating. Determine the rating life of the bearing.

3. A ball bearing subjected to a radial load of 4000 N is expected to have a satisfactory life of 12 000 hours at 720 r.p.m. with a reliability of 95%. Calculate the dynamic load carrying capacity of the bearing, so that it can be selected from manufacturer's catalogue based on 90% reliability. If there are four such bearings each with a reliability of 95% in a system, what is the reliability of the complete system?

4. A rolling contact bearing is subjected to the following work cycle : (*a*) Radial load of 6000 N at 150 r.p.m. for 25% of the time; (*b*) Radial load of 7500 N at 600 r.p.m. for 20% of the time; and (*c*) Radial load of 2000 N at 300 r.p.m. for 55% of the time. The inner ring rotates and loads are steady. Select a bearing for an expected average life of 2500 hours.

5. A journal bearing is proposed for a steam engine. The load on the journal is 3 kN, diameter 50 mm, length 75 mm, speed 1600 r.p.m., diametral clearance 0.001 mm, ambient temperature 15.5°C. Oil SAE 10 is used and the film temperature is 60°C. Determine the heat generated and heat dissipated. Take absolute viscosity of SAE10 at 60°C = 0.014 kg/m-s.

6. A journal bearing is to be designed for a centrifugal pump for the following data : Load on the journal = 12 kN ; Diameter of the journal = 75 mm ; Speed = 1440 r.p.m ; Atmospheric temperature of the oil = 16°C ; Operating temperature of the oil = 60°C; Absolute viscosity of oil at 60°C = 0.023 kg/m-s. Give a systematic design of the bearing.

7. Design a journal bearing for a centrifugal pump running at 1440 r.p.m. The diameter of the journal is 100 mm and load on each bearing is 20 kN. The factor *ZN/p* may be taken as 28 for centrifugal pump bearings. The bearing is running at 75°C temperature and the atmosphere temperature is 30°C. The energy dissipation coefficient is 875 W/m^2/°C. Take diametral clearance as 0.1 mm.

8. Determine the dimensions of an *I*-section connecting rod for a petrol engine from the following data: Diameter of the piston = 110 mm; Mass of the reciprocating parts = 2 kg; Length of the connecting rod from centre to centre = 325 mm; Stroke length = 150 mm; R.P.M. = 1500 with possible over speed of 2500; Compression ratio = 4: 1; Maximum explosion pressure = 2.5 N/mm^2.

9. A connecting rod is required to be designed for a high speed, four stroke I.C. engine. The following data are available. Diameter of piston = 88 mm; Mass of reciprocating parts = 1.6 kg; Length of connecting rod (centre to centre) = 300 mm; Stroke = 125 mm; R.P.M. = 2200 (when developing 50 kW); Possible over speed = 3000 r.p.m.; Compression ratio = 6.8: 1 (approximately); Probale maximum explosion pressure (assumed shortly after dead centre, say at about 3°) = 3.5 N/mm^2. Draw fully dimensioned drawings of the connecting rod showing the provision for the lubrication.

10. A ball bearing is subjected to a radial load of 10kN and a trust load of 5kN.The inner ring rotates at 1000 rpm.The average life is to be 5000 hours.What basic load rating must be used to select a bearing for this purpose? Take Fa/Fc=0.5 and assume service factor1.5.