

III B.Tech. I Semester Regular and Supplementary Examinations, December - 2013

DESIGN OF MACHINE MEMBERS - I

(Mechanical Engineering)

Time: 3 Hours**Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

- 1 (a) A shaft is transmitting 97.5kW at 180 r.p.m. If the allowable shear stress in the material is 60MPa, find the suitable diameter for the shaft. The shaft is not to twist more than 1° in a length of 3 meters. Take $G=80\text{GPa}$.
(b) What is the procedure adopted in the design of Machine elements?
- 2 (a) Write a short note on the influence of various factors of the endurance limit of a ductile material.
(b) A rotating bar made 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 315N/mm^2 . Calculate the fatigue strength of the bar for a life of 90,000cycle.
- 3 (a) What are the advantages of welded joints compared with riveted joints?
(b) Two plates of 10mm thickness are to be joined by a single riveted, double strap butt joint. Determine the rivet diameter, rivet pitch, strap thickness, and efficiency of the joint. Take $t=10\text{mm}$, $\tau=80\text{Mpa}$, $\sigma_s=60\text{Mpa}$ and $\sigma_c=120\text{Mpa}$.
- 4 (a) Discuss on bolts of uniform strength. Give examples of practical applications of such bolts.
(b) A shaft transmits 100kW at 240r.p.m to another shaft through a flange coupling. The bolts in the flange are arranged on a pitch circle of 200mm. Determine the number and size of bolts, if the permissible shear stress in the bolt material is 50MPa.
- 5 Two rods 40mm diameter is to be joined by a spigot and socket joint cotter joint to carry a load of 1MN in tension. Determine the dimensions of the spigot, socket, and cotter. The allowable stresses are:
Tension = 300MPa, Crushing = 450MPa, Shear= 225MPa
- 6 A hollow shaft 500mm outside diameter and 300mm inside diameter is used to drive a propeller of marine vessel. The shaft is mounted on bearings 6m apart and transmits 60,000kW at 150rpm. The maximum axial propeller thrust is 500kN and the shaft weighs 70kN. Determine
 - (a) The maximum shear stress developed in the shaft, and
 - (b) The angular twist between the bearings.

Take $G=84\text{GPa}$ 

Code No: R31035

- 7 Design a bushed-pin type flexible coupling for connecting a motor shaft to a pump shaft, with the following service conditions:
- Power to be transmitted=40kW
 - Speed of the motor shaft=1000rpm
 - Diameter of motor and pump shafts=45mm
 - Bearing pressure on the rubber bush= 0.7N/mm^2
 - Allowable stress in the pins=60MPa.
- 8 (a) What is a function of spring? Classify springs according to their shapes. In which type of spring the behavior is non-linear?
- (b) A helical spring is made from a wire of 6mm diameter and has outside diameter of 75mm. If the permissible shear stress is 350MPa and modulus of rigidity 84kN/mm^2 , find the axial load which the spring can carry and the deflection per active turn.



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- 1 (a) A cast iron pulley transmits 10kW at 400r.p.m. The diameter of the pulley is 1.2 meter and it has four straight arms of elliptical cross-section, in which the major axis is twice the minor axis. Determine the dimensions of the arm, if the allowable bending stress is 1.5MPa.
(b) What is meant by 'hole basis system' and 'shaft basis system'? Which one is preferred and why?
- 2 (a) What is high cycle fatigue? Give practical examples of high cycle fatigue failure.
(b) A machine component is subjected to fluctuating stress that varies from 40 to 100 N/mm^2 . The corrected endurance limit stress for the machine component is 270 N/mm^2 . The ultimate tensile strength and yield strength of material are 600 N/mm^2 and 450 N/mm^2 respectively. Find the factor of safety using
(i) Soderberg line
(ii) Goodman line
- 3 (a) Enumerate the different types of riveted joints and rivets.
(b) A double riveted lap joint is made between 15mm thick plates. The rivet diameter and pitch are 25mm and 75mm respectively. If the ultimate stresses are 400MPa in tension and 320MPa in shear and 640MPa in crushing, find the minimum force per inch, which will rupture the joint. If the above joint is subjected to a load such that the factor of safety is 4, find out the actual Stresses developed in the plates and the rivets.
- 4 (a) Derive an expression for the maximum load in a bolt when a bracket with circular base is bolted to a wall by means of four bolts.
(b) A pulley bracket is supported by 4 bolts as shown in Fig. 1. The weight of the pulley and the bracket is 1kN and the load is 25kN. Determine the size of the fixing bolts taking allowable shear stress in bolts to be 45 N/mm^2 .

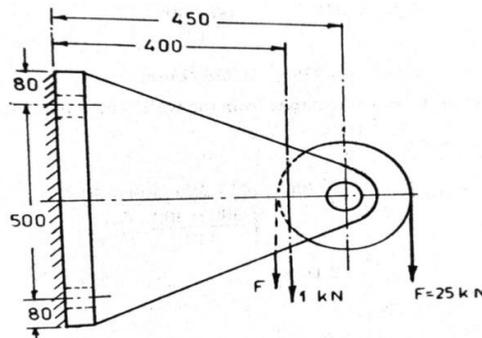


Fig. 1

All dimensions in
mm 1 of 2



- 5 Design a gib and cotter joint to carry a tensile load of 40kN. The material of the gib, cotter and rods is the same for which the allowable safe stresses are: Tension=24MPa, compression=59Mpa and, shear=19MPa.
- 6 A shaft is supported by two bearings placed 1.2m apart. A 600mm diameter pulley is mounted at a distance of 300mm to the right of left hand bearings and this drives a pulley directly below it with the help of a belt having maximum tension of 2kN. Another pulley 400mm diameter is placed 200mm to the left of right hand bearing and is driven with the help of an electric motor and belt which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and coefficient of friction is 0.24. Calculate the diameter of the shaft taking working stresses of 63MPa in tension and 42MPa in shear.
- 7 (a) The bolt in the flange coupling should be made weaker than the other components of coupling, Why?
(b) In a flange shaft coupling having 37.5mm bore it is desired that torsional stress in the shaft will not exceed 25 N/mm^2 . The outside diameter of the coupling limited by space is 200mm. There are three 15mm bolts on a bolt circle diameter of 140mm. The radial flange thickness is 18mm. Determine the following:
- The power that may be transmitted at 600 rev/min.
 - The shearing stress in the bolts.
 - The bearing pressure on the bolts.
- 8 (a) Discuss the materials and practical applications for various types of springs.
(b) Design a spring for a balance to measure 0 to 1000N over a scale of length 80mm. The spring is to be enclosed in a casing of 25mm diameter. The approximate number of turns is 30. The modulus of rigidity is 85 kN/mm^2 . Also calculate the maximum shear stress induced.



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- 1 (a) Write short notes on high speed steel and free cutting steel.
(b) A load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5kN. Find the diameter of bolt required according to
(a) Rankine's theory
(b) Vonmises theory
Take permissible tensile stress at elastic limit=100 MPa and Poisson's ratio=0.3.

- 2 (a) Discuss the effects of the following factors on endurance limit.
(i) Load factor (ii) Surface finish factor (iii) Size factor
(b) A steel rod is subjected to a reversed axial load of 180kN. Find the diameter of the rod for a factor of safety of 2. Neglect column action. The material has an ultimate tensile strength of 1070 MPa and yield strength of 910 MPa. The endurance limit in reversed bending may be assumed to be one half of the ultimate tensile strength. The correction factors are as follows.
Load factor =0.7; surface finish factor=0.8
Size factor =0.85; stress concentration factor = 1.

- 3 (a) Classify the rivet heads according to Indian Standard Specification.
(b) A bracket plate 20mm thick is welded to the flange of a column by fillet welds on either side of the plate as shown in figure 1.. If the size of the weld is 8mm, calculate the length of the weld required if the allowable stress for the welds is 79N/mm^2

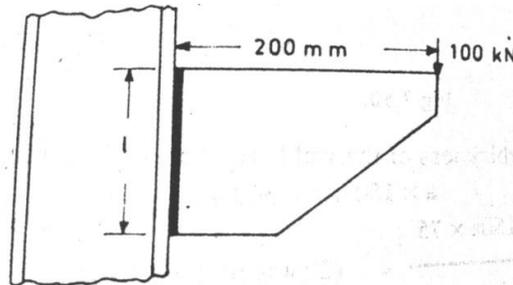


Fig. 1

- 4 (a) Define the following terms with necessary sketch.
(i) Major diameter (ii) Minor diameter (iii) Pitch (iv) Lead.
(b) The cylinders head of a steam engine is subjected to a steam pressure of 0.7 N/mm^2 . It is held in position by means of 12 bolts. A soft copper gasket is used to make the joint leak proof. The effective diameter of the cylinder is 300mm. Find the size of the bolt so that the stress in the bolt is not exceed 100N/mm^2 .



- 5 (a) What is the difference between a cotter and key? Why a single taper is provide in cotter and not on both sides? Discuss the advantages and limitations of cotter joint.
- (b) Two mild steel rods of 36mm diameter are to be connected by means of a cotter joint. The ends of the rod to be suitably enlarged by forging. The thickness of the cotter is 12mm. Calculate the dimensions of the joint, if the permissible stresses are 60MPa in tension, 45MPa in shear, and 90MPa in compression.
- 6 A mild steel shaft transmits 20kW at 200r.p.m. It carries a central load of 900N and is simply supported between the bearings 2.5m apart. Determine the size of the shaft, if the allowable shear stress is 42MPa and the maximum tensile or compressive stress is not to exceed 56MPa. What size of the shaft will be required, if it is subjected to gradually applied loads?
- 7 (a) What is coupling? What are the requirements of a good coupling? Give at least three practical applications of couplings?
- (b) A rigid coupling is used to transmit 50kW power at 300rpm. There are six bolts the outer diameter of flanges is 200mm, while the recess diameter is 150mm. The coefficient of friction between the flanges is 0.15. The bolts are made of steel 45C8 ($S_{yt}=380\text{N/mm}^2$) and the factor of safety is 3. Determine the diameter of the bolts. Assume that the bolts are set in large clearance holes.
- 8 (a) What is nipping in a leaf spring? Discuss its role. List the materials commonly used for the manufacture of the leaf springs?
- (b) A truck spring has 12 number of leaves, two of which are full length leaves. The spring supports are 1.05m apart and the central band is 85mm wide. The central load is to be 5.4kN with a permissible stress of 280MPa. Determine the thickness and width of the steel spring leaves. The ratio of the total depth to the width of the spring is 3. Also determine the deflection of the spring.



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- 1 (a) A mild steel shaft of 50mm diameter is subjected to a bending moment of 2000N-m and a torque T. If the yield point of the steel in tension is 200MPa, find the maximum value of this torque without causing yielding of the shaft according to
 - (i) Guest's theory (ii) Haigh's theory
 (b) Explain the desirable properties of engineering materials used in mechanical engineering design.

- 2 (a) What is notch sensitivity factor? What is the physical significance of notch sensitivity factor being one and zero?
 (b) A circular bar of 500mm 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 50kN. Determine the diameter of the 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 500MPa and endurance strength of 350 MPa.

- 3 (a) What is the difference between Caulking and fullering? Explain with the help of neat sketches.
 (b) A plate of 100mm wide and 10mm thick is to be welded with another plate by means of a transverse welds at the ends. If the plates are subjected to a load of 70kN, find the size of the weld for static as well as fatigue load. The permissible tensile stress should not exceed 70MPa.

- 4 (a) Explain the method of determining the size of the bolt when the bracket carries an eccentric load perpendicular to the axis of the bolt.
 (b) For supporting the travelling crane in a workshop, the brackets are fixed on steel columns as shown in figure 1. The maximum load that comes on the bracket is 12kN acting vertically at a distance of 400mm from the face of the column. The vertical face of the bracket is secured to a column by four bolts, in two rows (two in each row) at a distance of 50mm from the lower edge of the bracket. Determine the size of the bolts if the permissible value of the tensile stress for the bolt material is 84MPa. Also find the cross-section of the arm of the bracket which is rectangular

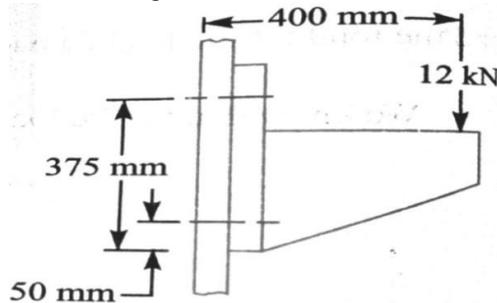


Fig. 1



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R10

Set No: 4

- 5 (a) What is the difference between a knuckle and a cotter joint? Where is the use of knuckle joint is best suited, give some examples of its use.
- (b) Design a cotter joint with two gibs to transmit an axial force of 130kN. The permissible stresses are 165MPa in tension; 100 MPa in shear and 180MPa in crushing.
- 6 In axial flow rotary compressor, the shaft is subjected to a maximum twisting moment of 1500N-m and a maximum bending moment of 3000N-m. Neglecting the axial load on the shaft, determine the diameter of the shaft, if the allowable shear stress is 50N/mm^2 . Assume $K_b = 1.5$ and $K_t = 1.2$. If the shaft is to be a hollow one with $d_i/d_o=4$, what will be the material saving in the hollow shaft. It is subjected to the same loading and of the same material as the solid shaft. Compare the torsional stiffness of the two shafts.
- 7 (a) What are advantages and disadvantages of bushed-pin flexible coupling? In bushed flexible coupling why there is a clearance between flanges?
- (b) Design a muff coupling to connect two shafts transmitting 40kW at 150rev/min. The allowable shear and crushing stresses for the shaft and key, which are made of 50C8 steel, are 37N/mm^2 and 96.25N/mm^2 respectively. The material of the muff is FG 150 cast iron with a permissible shear strength of 17.3N/mm^2 . Assume that the maximum torque transmitted is 20% greater than the mean torque.
- 8 (a) Write a short notes on the following.
- (i) Springs under fatigue loading.
 - (ii) Leaf springs.
- (b) A closely coiled helical spring is made of 10mm diameter steel wire, the coil consisting of 10 complete turns with a mean diameter of 120mm. The spring carries an axial pull of 200N. Determine the shear stress induced in the spring neglecting the effect of stress concentration. Determine also the deflection in the spring, its stiffness and strain energy stored by it if the modulus of rigidity of material is 80kN/mm^2
