Code No: R2031032 **R20** SET - 1

III B. Tech I Semester Regular/Supplementary Examinations, December -2023
DESIGN OF MACHINE MEMBERS - I
(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions **ONE** Question from **Each unit**
All Questions Carry Equal Marks
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UNIT-I

1. a) Enumerate the most commonly used engineering materials and state at least one important property and application of each. [7M]
   b) What are the general considerations need to be followed while designing a machine element? [7M]

(OR)

2. a) Explain the salient features of the maximum principal stress theory and indicate under what conditions such a theory is useful? [7M]
   b) Define the following properties of a material: [7M]
   i) Ductility ii) Toughness iii) Hardness and iv) Creep.

UNIT-II

3. a) A round shaft made of cold finished AISI 1020 steel is subjected to a variable torque whose maximum value is 700 KN-m. For a factor of safety of 1.5 on the Soderberg criterion, determine the diameter of the shaft if [10M]
   i) The torque is reversed
   ii) The torque varies from zero to maximum
   iii) The torque varies from 300 N m to a maximum.
   Assume,
   Correction factor for type of loading other than bending = 0.6
   Size correction factor = 0.85
   Surface correction factor = 0.87
   Ultimate tensile strength =550 MPa.
   Yield strength = 460 MPa
   b) Explain notch sensitivity. [4M]

(OR)

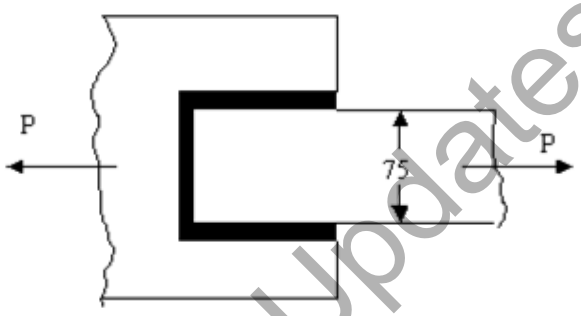
4. a) A hot rolled shaft is subjected to torsional load that varies from 320 Nm Clockwise to 120Nm anti-clockwise and an applied bending moment at a critical section varies from 400Nm to 200Nm. The shaft is of uniform cross section. Determine the required shaft diameter. The material has an ultimate strength of 560MPa and yield strength of 420 MPa. Assume factor of safety to be 2. [7M]
   b) Discuss the effects of the following factors on endurance limit. [7M]
   i) Load factor ii) Surface finish factor iii) size factor.

UNIT-III

5. a) What do you understand by the term riveted joint? Explain the necessity of such a joint. [4M]
   b) Two steel rods are to be connected by means of a sleeve, and two steel cotters. The rods are subjected to a tensile load of 40kN. Design the joint, using the permissible stress in tension as 60MPa, in shear as 50MPa, and in crushing as 120MPa. [10M]

(OR)

6. a) What do you understand by the term welded joint? How it differs from the riveted joint? [4M]
   b) A plate 75 mm wide and 12.5 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld as shown in Figure. The maximum tensile and shear stresses are 70 MPa and 56 MPa respectively. Find the length of each parallel fillet weld, if the joint is subjected to both static and fatigue loading. Assume a length of 12.5 mm for starting and stopping of weld run. Take stress concentration factor for transverse weld as 1.5 and for parallel fillet welds as 2.5. [10M]



UNIT-IV

7. A shaft is supported on two bearings 1800mm apart and rotates at 800 rpm. Two pulleys B and C are located on the shaft at distance of 600mm and 1350 mm respectively to the right of the left bearing. The distance of the pulleys B and C are 750 mm and 600 mm respectively. 50kW power is supplied to the shaft through pulley B and output is through pulley C. The drive to pulley B is vertically downward while from C the drive is downward at an angle of 600 to the horizontal. In both cases the tension ratio is 2 and the angle of lap is 1800. The combined fatigue and shock factors for tensions and bending may be taken. Working stresses to be 40N/mm2 in shear and 80N/mm2 in tension. [14M]

(OR)

8. Design a clamp coupling completely for a shaft diameter of 50mm. The torsional moment to be transmitted by this coupling taking in to account overloading is 140Nm. The number of bolts used is 4 and the allowable stress in the material of the bolt is limited to 70 N/mm2. The coefficient of friction between the shaft and muff material is 0.3. Draw sectional elevation of the designed clamp coupling. [14M]

UNIT-V

9. A helical compression spring is required to exert a force of 35 N when compressed to a length of 60mm. At a length of 48 mm the force must be 50N.The spring is to be installed in a hole with a diameter of 24mm.The application involves slow cycling and a total life of 250 000 cycles is required. The maximum temperature of operation is $80^{O}C$ [7M]

(OR)

10. a) What are the Principal characteristics of different types of springs [7M]
    b) Classify springs according to their shape. Draw neat sketches indicating in each [7M]

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UNIT-I

1. a) Discuss in detail the factors which govern the selection of material for a machine component? [7M]
   b) What is an Engineering design? Explain the stages in the design of machine members. [7M]

(OR)

2. a) A shaft is designed based on maximum distortion energy theory with a factor of safety of 2.0. The material used is 30C8 steel with a yield stress of 310 MPa. It is subjected to an axial load of 40 kN. Determine the maximum torque capacity. Diameter of the shaft is 20 mm. [7M]
   b) State and explain any two theories of failure. [7M]

UNIT-II

3. a) Explain the effect of the following factors on the type of fatigue failure [7M]
   i) Range of imposed stress ii) Surface treatment
   b) A circular bar of 0.5 m 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 factor of 0.85, surface finish factor of 0.9. The material properties of bar are given by: [7M]
   Ultimate strength of 650 MPa,
   Yield strength of 500 MPa, and
   Endurance strength of 350 MPa.

(OR)

4. a) A rotating shaft carries a 18 KN pulley at the center of a 0.75 m simply supported span. The average torque is 230 N m. Assume the torque range to be 10 % of the average torque. The material has yield point of 770 MPa and the endurance limit of 450MPa.Determine the required diameter of the shaft based on [10M]
   i) Maximum stress theory and
   ii) Distortion energy theory.
   Stress concentration factor may be taken as 1.5 and a factor of safety 2.
   b) Define stress concentration factor. [4M]

UNIT-III

5. a) A double riveted lap joint is made between 15-mm thick plates. The rivet diameter and pitch are 25 mm and 75 mm respectively. If the ultimate stresses are 400 MPa in tension, 320 MPa in shear and 640 MPa in crushing, find the minimum force per pitch which will rupture the joint. If the above joint is subjected to a load such that the factor of safety is two, find out the actual stresses developed in the plates and the rivets. [10M]
   b) Sketch and discuss the various types of welded joints used in pressure vessels. [4M]

(OR)

6. a) What is the difference between a knuckle and a cotter joint? Where the use of knuckle joint is best suited, give some examples of its use. [7M]

   b) Design and sketch a cotter joint for fastening the piston rod to the cross head of the engine having cylinder diameter 250mm and steam pressure 1.05N/mm^2. The thickness of the cotter is to be 0.3 times piston rod diameter at the point where cotter is located. Allowable stresses in tension, shear and compression are 50 N/mm^2, 40N/mm^2 and 84 N/mm^2 respectively. [7M]

UNIT-IV

7. a) What is the effect of keyway on: [7M]
   i) Strength of shaft, ii) Torsional rigidity of Shaft.

   b) A shaft, 2m long between bearings, carries a 900N pulley at its mid-point. Through a belt drive, the shaft receives 25kW at 180 r.p.m. The belt drive is horizontal, and the sum of the belt tensions is 7kN. Determine the shaft diameter and angle of twist, the shaft undergoes. Take G= 80GN/m^2. [7M]

(OR)

8. a) The bolt in the flange coupling should be made weaker than the other components of coupling, Why? [7M]

   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: [7M]
   i) The power that may be transmitted at 600 rev/min.
   ii)The shearing stress in the bolts.
   iii) The bearing pressure on the bolts.

UNIT-V

9. A helical spring is to support a load of 1000N. The spring is guided by a rod of 50mm diameter. The spring undergoes a deflection of 40 mm under the load. Determine the diameter of the wire and the number of turns required, Use C-60 steel with a factor of safety 2. [14M]

(OR)

10. a) Why the circular cross section is most commonly used for spring and not others? Under what circumstances the non- circular section would be recommended. [7M]

    b) Design a helical spring for a spring loaded safety valve from the following data: [7M]
    Valve diameter = 65mm
    Maximum pressure when the valve blows off freely = 0.75 N/mm^2
    Valve lift when pressure rises from 0 .7 to 0.75 N/mm =3mm
    Maximum permissible stress in the material of the spring =500 N/mm^2
    Spring index = 6
    Modulus of rigidity of the spring material = 1×10^5 N/mm^2

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UNIT-I

1. a) Write a note on important non-metallic materials of construction in engineering practice? [7M]
   b) Write a brief note on different phases of design. [7M]

(OR)

2. a) A 50mm diameter steel shaft is supported on bearings 1.5m apart and carries a fly wheel weighing 'W'. The allowable bending stress for the shaft material and the maximum deflection are limited to 100MPa and 2 mm respectively. The young's modulus for the shaft material is 210GPa. Determine the Maximum permissible weight of the flywheel. [10M]
   b) Briefly explain the concept of shear stress and shear strain? [4M]

UNIT-II

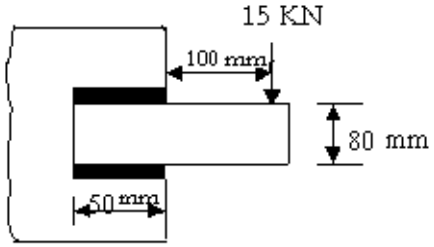
3. a) A steel connecting rod is subjected to a completely reversed axial load of 120 KN. Suggest the suitable size of the rod using a factor of safety 1.8.
   The ultimate strength of the material is 1000 MPa.
   Load correction factor 0.7
   Size factor 0.85
   Surface finish factor 0.8 [7M]
   b) Explain the effect of the following factors on the type of fatigue failure.
   i) Strain rate ii) Type of material iii) Manner of loading [7M]

(OR)

4. a) Explain the effect of the following factors on the type of fatigue failure.
   i) Stress distribution ii) Surface treatment [7M]
   b) A shaft is made of steel [ultimate tensile strength 700 MPa and yield point 420 MPa is subjected to a torque varying from 200N m] anti-clockwise to 600 N m clockwise. Calculate the diameter of the shaft if the factor of safety is 2 and it is based on the yield point and the endurance strength in shear. [7M]

UNIT-III

5. a) A bracket carrying a load of 15 KN is to be welded as shown in Figure. Find the size of weld required if the allowable shear stress is not to exceed 80 MPa. [10M]



   b) Enumerate the different types of riveted joints. [4M]

(OR)

6. a) Differentiate between a cotter and a key. [4M]
   b) Design a gib and cotter joint to resist safely a tensile load of 40kN. The material of the gib, cotter and rods is same for which the allowable safe stresses are: σ_c=60 N/mm^2, σ_t=25 N/mm^2 and τ_s =20 N/mm^2. [10M]

UNIT-IV

7. a) Explain the reasons for preferring hollow shafts over solid shafts. [4M]
   b) A shaft, 2m long between bearings, carries a 900N pulley at its mid-point. Through a belt drive, the shaft receives 25kW at 180 r.p.m. The belt drive is horizontal, and the sum of the belt tensions is 7kN. Determine the shaft diameter and angle of twist, the shaft undergoes. Take G= 80GN/m^2. [10M]

(OR)

8. a) What are the causes of failure of shaft? [4M]
   b) A hollow shaft 0.5m outside diameter and 0.3m inside diameter is supported by two bearings 6m apart, the shaft is driven by a flexible coupling at one shaft end and drives a ship's propeller at 10.5 rad/sec. The maximum thrust on the propeller is 540kN when the shaft is transmitting 5885kW. The shaft weight is 67.5kN. Determine the maximum shear stress in the shaft considering the weight of the shaft and the column effect. Assume K_b= 1.5 and K_s=1.0. [10M]

UNIT-V

9. A semi elliptical lamented spring is to carry of load of 5000N and consists 8 leaves 46 mm wide, two of the leaves being of full length. The spring is to be made 1000mm between the eyes and is held at the center by a 60mm wide band. Assume that the spring is initially stressed so as to induce an equal stress of 500N/mm^2 when fully loaded. Design the spring [14M]
   i) Thickness of leaves
   ii) Eye diameter
   iii) Length of leaves
   iv) Maximum deflection and camber. Assume E = 2.1×10^5 N/mm^2.

(OR)

10. a) Write short notes on leaf springs [4M]
    b) A lift system is provided with cushion springs at the bottom of lift. The lift is free to fall. Springs are set in parallel. Specify the required number of springs if the lift has free fall of 1.5m from rest. [10M]
    Weight of lift = 30kN
    Allowable deflection per spring = 370 mm
    Number of active turns =15
    Spring mean coil diameter =30 mm
    Spring wire diameter = 30mm
    Modulus of rigidity for spring =80Gpa.

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UNIT-I

1. a) Explain the following terms: i) Conceptual design ii) Innovative design. [7M]
   b) Discuss various general considerations that are taken into account while designing a machine element. [7M]

(OR)

2. a) Explain about the Maximum Normal Stress, Maximum Shear Stress and Maximum Distortion Energy Theories. [7M]
   b) The principal stresses induced at a point in a machine component made of steel 50C4(Syt = 460 N/mm2) are as follows: Maximum principal stress = 200 N/mm2 and Minimum principal stress = 150 N/mm2. Calculate the factor of safety by i) Maximum shear stress theory and ii) Distortion energy theory. [7M]

UNIT-II

3. a) Explain the following methods of reducing stress concentration. i) Removal of undesired material ii) Added grooves [7M]
   b) A stepped shaft transmits a torque varying from 800 N m to 1200 N m. The ratio of diameter is 1.5 and the stress concentration factor is 1.2. Determine the diameter of the shaft for an infinite life for a design factor of safety 1.8. The ultimate tensile strength of the material of the shaft is 600 MPa. Yield stress of the material is 450 MPa. Consider the size effect and surface finish effect. [7M]

(OR)

4. a) A steel connecting rod is subjected to a completely reversed axial load of 1,600 MPa. Suggest the suitable diameter of the rod using a factor of safety 2. The ultimate tensile strength of the material is 1,100 MPa and yield strength 930 MPa. Neglect column action and the effect of stress concentration. [7M]
   b) Explain the following methods of reducing stress concentration i) Drilled holes ii) Using large fillet radius iii) Added grooves [7M]

UNIT-III

5. a) What do you understand by the term riveted joint? Explain the necessity of such a joint. [4M]
   b) Two plates 16 mm thick are joined by a double riveted lap joint. The pitch of each row of rivets is 90 mm. The rivets are 25 mm in diameter. The permissible stresses are 140 MPa in tension, 80 MPa in shear and 160 MPa in crushing. Find the efficiency of the joint. [10M]

(OR)

6. a) What is a key? Where it is used? In what basis it is selected? [4M]
   b) Design a gib and cotter joint to connect square rods with a side of the square as 25mm. Consider σt = 60MPa σc = 90MPa and τ = 40MPa. The joint has to carry a load of 35kN. (t=8mm, B=55(30+25)mm and length of the tail of the rod is 12mm. [10M]

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UNIT-IV

7. A plane flange coupling for a 75mm shaft has the following dimensions: bore of flange=75mm, hub diameter=135mm, hub length=100mm, flange diameter=250mm, flange thickness=28mm, bolt circle diameter=200mm, bolt diameter=19mm, number of bolts=6, and the key size is 18mm square. All the parts are made of carbon steel having a shearing strength of 400N/mm2 and a tensile strength of 650N/mm2. This coupling is rated at 37.3kW power at 100rev/min. [14M]
i) Determine the shearing, bearing and tensile stresses in all parts of the coupling.
ii) What F.O.S does this coupling have?
iii) Is there a possibility of the flange shearing off at the hub? Assume perfect shaft alignment.

(OR)

8. Design a cast iron protective type flange coupling to connect two shafts in order to transmit 7.5kW at 720rpm. The following permissible stresses may be used [14M]
Permissible shear stress for shaft, bolt and key material = 33MPa
Permissible crushing stress for shaft, bolt and key material = 60MPa
Permissible shear stress for the cast iron = 15MPa

UNIT-V

9. a) List out the functions of springs. [4M]
b) A spring for spring balance is to elongate 100mm, when subjected to a load of 200N. Assume that the mean diameter of the coil is to be 6 times the diameter of the wire and the maximum stress to be induced is limited to 400N/mm2. Determine the diameter for the wire, for the coil and the number of coils required and length of spring. Modulus of rigidity G= 0.8 ×105 N/mm^2. [10M]

(OR)

10. A semi-elliptical laminated spring is made of no.10.B.W.G. steel 50mm wide. The length between the supports is 66.25cm and the band is 63 mm wide. The spring has two full length and five graduated leaves. A central load if 158 kg is carried. [14M]
i) Determine the maximum stress in each set of leaves for an initial condition of no stress in the leaves.
ii) Draw to half or quarter full size the elevation and plan of the spring
iii) Determine the maximum stress if the initial stress is provided to cause equal stresses when loaded.
iv) Determine the deflection in parts (a) and (b) respectively.

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