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

III B. Tech I Semester Regular Examinations, Dec/Jan – 2022-23
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
*****

UNIT-I

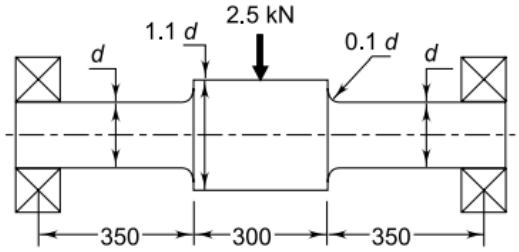
1. a) Discuss various general considerations in Machine Design. [7M]
   b) Define (i) Basic Size, (ii)Allowance, (iii) Tolerance and (iv)Mean deviation [7M]

(OR)

2. a) What is factor of safety? Discuss about various factors involving in factor of safety. [7M]
   b) A mild steel shaft of 50 mm diameter is subjected to a bending moment of 2000 N-m and a torque T. If the yield point of the steel in tension is 200 MPa, find the maximum value of this torque without causing yielding of the shaft according to i) the maximum principal stress and ii) the maximum shear stress. [7M]

UNIT-II

3. a) What is stress concentration factor? Discuss the causes of stress concentration. [6M]
   b) A non-rotating shaft supporting a load of 2.5 kN is shown in Figure. The shaft is made of brittle material, with an ultimate tensile strength of 300 N/mm^2. The factor of safety is 3 and theoretical stress concentration factor is 1.61. Determine the dimensions of the shaft. [8M]



Figure

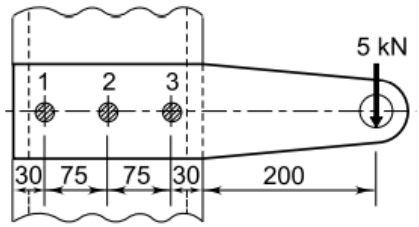
(OR)

4. a) Explain the modified Goodman diagram for bending stresses. [6M]
   b) A machine component is subjected to two-dimensional stresses. The tensile stress in the X direction varies from 40 to 100 N/mm^2 while the tensile stress in the Y direction varies from 10 to 80 N/mm^2. The frequency of variation of these stresses is equal. The corrected endurance limit of the component is 270 N/mm^2. The ultimate tensile strength of the material of the component is 660 N/mm^2. Determine the factor of safety used by the designer. [8M]

|'''|'|'|''|''||'|||

UNIT-III

5. a) A steel plate subjected to a force of 5 kN and fixed to a channel by means of three identical bolts is shown in Figure. The bolts are made from plain carbon steel 45C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 3. Specify the size of bolts. (S_{yt}=yield strength) [10M]

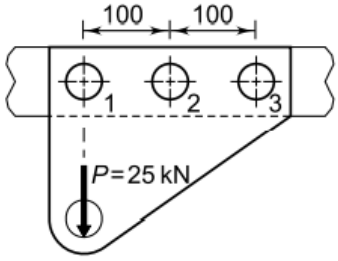


Figure

b) What is bolted joint? List out the advantages and disadvantages of bolted joints. [4M]

(OR)

6. a) A bracket is attached to a horizontal column by means of three identical rivets as shown in Figure. The maximum permissible shear stress for the rivets is 60 N/mm^2. (i)Which rivet is subjected to maximum shear force? (ii) What is the magnitude of maximum force? (iii) Determine the diameter of rivet. [7M]



Figure

b) It is required to design a square key for fixing a gear on a shaft of 25 mm diameter. The shaft is transmitting 15 kW power at 720 rpm to the gear. The key is made of steel 50C4 (S_{yt} = 460 N/mm^2) and the factor of safety is 3. For key material, the yield strength in compression can be assumed to be equal to the yield strength in tension. Determine the dimensions of the key. [7M]

UNIT-IV

7. a) Discuss about equivalent torsional moment and equivalent bending moment. [7M]

b) A propeller shaft is required to transmit 50 kW power at 600 rpm. It is a hollow shaft, having an inside diameter 0.8 times of the outside diameter. It is made of steel (S_{yt} = 380 N/mm^2) and the factor of safety is 4. Calculate the inside and outside diameters of the shaft. Assume (S_{sy} = 0.5S_{yt}) [7M]

(OR)

8. a) What is the difference between rigid and flexible couplings? Explain. [4M]
   b) A rigid coupling is used to connect a 45 kW, 1440 rpm electric motor to a centrifugal pump. The starting torque of the motor is 225% of the rated torque. There are 8 bolts and their pitch circle diameter is 150 mm. The bolts are made of steel 45C8 (S^{yt} = 380 N/mm^2) and the factor of safety is 2.5. Determine the diameter of the bolts. Assume (S_{sy} = 0.577S_{yt}) Assume that the bolts are finger tight in reamed and ground holes. [10M]

UNIT-V

9. a) Design a helical spring for a spring loaded safety valve for the following conditions : Operating pressure = 1 N/mm^2 Maximum pressure when the valve blows off freely = 1.075 N/mm^2 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 [10M]
   b) What type of stress is induced in helical extension spring? [4M]

(OR)

10. a) Discuss about various types of applications of spring [4M]
    b) It is required to design a helical compression spring subjected to a force of 500 N. The deflection of the spring corresponding to this force is approximately 20 mm. The spring index should be 6. The spring is made of cold-drawn steel wire with ultimate tensile strength of 1000 N/mm^2. The permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength (G = 81 370 N/mm^2). Design the spring and calculate: (i) wire diameter; (ii) mean coil diameter; (iii) number of active coils; (iv) total number of coils; (v) free length of the spring; and (vi) pitch of the coils. Assume a gap of 1 mm between adjacent coils under maximum load condition. The spring has square and ground ends. [10M]

Code No: R2031032 **R20** SET - 2

III B. Tech I Semester Regular Examinations, Dec/Jan – 2022-23
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
*****

UNIT-I

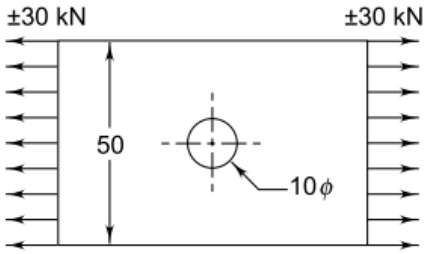
1. a) Discuss general Procedure in machine design for solving any design problem. [7M]
   b) Define (i) Creep, (ii) Fatigue, (iii) Malleability, (iv) Resilience. [7M]

(OR)

2. a) What are the three basic modes of failure of mechanical components? [7M]
   b) Discuss about various theories of failures. [7M]

UNIT-II

3. a) What is the difference between the Gerber curve and Soderberg and Goodman lines? [4M]
   b) A plate made of steel 20C8 (S_{ut} = 440 N/mm^2) in hot rolled and normalised condition is shown in Figure. It is subjected to a completely reversed axial load of 30 kN. The notch sensitivity factor q can be taken as 0.8 and the expected reliability is 90%. The factor of safety is 2. The surface finish factor 0.67, size factor 0.85, and the theoretical stress concentration factor is 2.51. Determine the plate thickness for infinite life. [10M]



Figure

(OR)

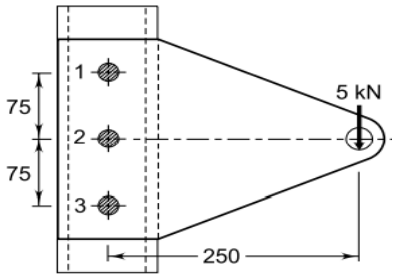
4. a) A machine component is subjected to a flexural stress which fluctuates between + 300 MN/m^2 and – 150 MN/m^2. Determine the value of minimum ultimate strength according to i) Gerber relation; ii)Modified Goodman relation; and iii) Soderberg relation. [7M]
   Take yield strength = 0.55 Ultimate strength; Endurance strength = 0.5, Ultimate strength; and factor of safety = 2
   b) Explain the modified Goodman diagram for torsional shear stresses. [7M]

|'''|'|'|''|'||'|||

UNIT-III

5. a) Describe the design procedure of a gib and cotter joint. [7M]

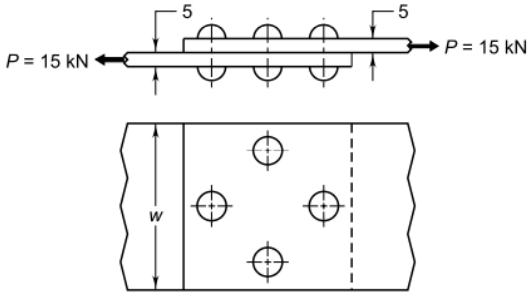
   b) A steel plate subjected to a force of 5 kN and fixed to a channel by means of three identical bolts is shown in Figure. The bolts are made of plain carbon steel 30C8 (S_{yt} = 400 N/mm^2) and the factor of safety is 3. Determine the diameter of the shank. [7M]



Figure

(OR)

6. a) Two plates, each 5 mm thick, are connected by means of four rivets as shown in Figure. The permissible stresses for rivets and plates in tension, shear and compression are 80, 60 and 120 N/mm^2 respectively. Calculate: (i) diameter of the rivets; (ii) width of the plate; and (iii) efficiency of the joint. [7M]



Figure

   b) 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 = 50 MPa ; shear stress = 35 MPa and crushing stress = 90 MPa [7M]

UNIT-IV

7. a) What are the various types of stresses are induced in shafts ? [4M]

   b) A centrifugal pump is driven by 10 kW power 1440 rpm electric motor. There is a reduction gearbox between the motor and the pump. The pump shaft rotates at 480 rpm. The design torque is 150% of the rated torque. The motor and pump shafts are made of plain carbon steel 40C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 4. Assume (S_{sy} = 0.5S_{yt}) Calculate: (i) diameter of the motor shaft ;and (ii) diameter of the pump shaft. [10M]

(OR)

8. a) What is the difference between protected and unprotected rigid flange couplings? [4M]

   b) A protective flange coupling is used to connect two shafts and transmit 7.5 kW power at 720 rpm. The design torque is 150% of the rated torque. The shafts and bolts are made of plain carbon steel 30C8 (S_{yt} = 400 N/mm^2) and the factor of safety is 5. Assume, S_{yc} = 1.5 S_{yt} and S_{sy} = 0.5 S_{yt} The flanges are made of cast iron. Calculate: (i) diameter of the shafts; (ii) number of bolts; and (iii) diameter of the bolts. [10M]

UNIT-V

9. a) Define the following terms of the spring : [4M]
   (i) Spring rate; (ii) Active and inactive coils; (iii) Spring index;

   b) A helical compression spring is required to deflect through approximately 25 mm when the external force acting on it varies from 500 to 1000 N. The spring index is 8. The spring has square and ground ends. There should be a gap of 2 mm between adjacent coils when the spring is subjected to the maximum force of 1000 N. The spring is made of cold-drawn steel wire with ultimate tensile strength of 1000 N/mm^2 and permissible shear stress in the spring wire should be 50% of the ultimate tensile strength (G = 81 370 N/mm^2). Design the spring and calculate: (i) wire diameter; (ii) mean coil diameter; (iii) number of active coils; (iv) total number of coils; (v) solid length; (vi) free length; (vii) required spring rate; and (viii) actual spring rate. [10M]

(OR)

10. a) Discuss the materials and practical applications for the various types of springs. [4M]

    b) A flat spiral spring is required to provide a maximum torque of 1000 N-mm. It is made of steel strip (E = 207 000 N/mm^2) and the maximum bending stress in the strip should not exceed 750 N/mm^2. The ratio of width to thickness of the strip is 10. The arbor turns through 2.5 revolutions with respect to the retaining drum to provide the required torque. Calculate the thickness, width and length of strip. [10M]

Code No: R2031032 **R20** SET - 3

III B. Tech I Semester Regular Examinations, Dec/Jan – 2022-23
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
*****

UNIT-I

1. a) Discuss about the physical and mechanical properties of metals. [7M]
   b) What is Fit? Explain various types of fits. [7M]

(OR)

2. a) State maximum principle stress and shear stress theory of failure. [7M]
   b) Two rods are connected by means of a cotter joint. The inside diameter of the socket and outside diameter of the socket collar are 50 and 100 mm respectively. The rods are subjected to a tensile force of 50 kN. The cotter is made of steel 30C8 (S_{yt} = 400 N/mm^2) and the factor of safety is 4. The width of the cotter is five times of thickness. Calculate: [7M]
      (i) width and thickness of the cotter on the basis of shear failure; and
      (ii) Width and thickness of the cotter on the basis of bending failure.

UNIT-II

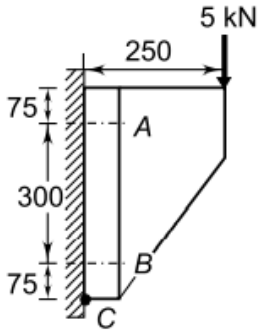
3. a) What is notch sensitivity? Discuss about notch sensitivity factor? [4M]
   b) A rod of a linkage mechanism made of steel 40Cr1 (S_{ut} = 550 N/mm^2) is subjected to a completely reversed axial load of 100 kN. The rod is machined on a lathe and the expected reliability is 95%. There is no stress concentration. Determine the diameter of the rod using a factor of safety of 2 for an infinite life condition. The surface finish factor 0.78, and size factor 0.85. [10M]

(OR)

4. a) A polished steel bar is subjected to axial tensile force that varies from zero to P_{max}. It has a groove 2 mm deep and having a radius of 3 mm. The theoretical stress concentration factor and notch sensitivity factor at the groove are 1.8 and 0.95 respectively. The outer diameter of the bar is 30 mm. The ultimate tensile strength of the bar is 1250 MPa. The endurance limit in reversed bending is 600 MPa. Find the maximum force that the bar can carry for 105 cycles with 90% reliability. The surface finish factor is 1, and size factor 0.85. [10M]
   b) What is the difference between the Gerber curve and Soderberg and Goodman lines? [4M]

UNIT-III

5. a) A bracket for supporting the travelling crane is shown in Figure. The bracket is fixed to the steel column by means of four identical bolts, two at A and two at B. The maximum load that comes on the bracket is 5 kN acting vertically downward at a distance of 250 mm from the face of the column. The bolts are made of steel 40C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 5. Determine the major diameter of the bolts on the basis of maximum principal stress. Assume (d_c = 0.8d). [10M]



Figure

b) Briefly discuss about maximum shear stress in parallel fillet weld. [4M]

(OR)

6. a) Design a sleeve and cotter joint to resist a tensile load of 60 kN. All parts of the joint are made of the same material with the following allowable stresses: σ_t = 60 MPa ; τ = 70 MPa ; and σ_c = 125 MPa. [7M]

b) Describe the design procedure of a gib and cotter joint. [7M]

UNIT-IV

7. a) Design of hollow shaft on torsional rigidity basis. [7M]

b) A rotating shaft, 40 mm in diameter, is made of steel FeE 580 (S_{yt} = 580 N/mm^2). It is subjected to a steady torsional moment of 250 N-m and bending moment of 1250 N-m. Calculate the factor of safety based on, (i) maximum principal stress theory; and (ii) maximum shear stress theory. [7M]

(OR)

8. a) Discuss the design procedure for flexible coupling. [7M]

b) 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 rpm to the output shaft through the coupling. The service factor for the application is 1.5, i.e., the design torque is 1.5 times of the rated torque. Select suitable materials for various parts of the coupling, design the coupling and specify the dimensions of its components. [7M]

UNIT-V

9. a) Discuss various type of stress is induced in helical torsion spring? [4M]

   b) A direct reading spring balance consists of a helical tension spring, which is attached to a rigid support at one end and carries weights at the other free end. The pointer attached to the free end moves on a scale and indicates the weight. The length of the scale is 75 mm. The maximum capacity of the balance is to measure the weight of 500 N. The spring index is 6. The spring is made of oil-hardened and tempered steel wire with ultimate tensile strength of 1400 N/mm^2. The permissible shear stress for spring wire can be taken as 50% of the ultimate tensile strength (G = 81 370 N/mm^2). Design the spring and calculate: (i) wire diameter; (ii) mean coil diameter; (iii) number of active coils; (iv) required spring rate; and (v) actual spring rate [10M]

(OR)

10. a) Explain the following terms of the spring : (i) Free length; (ii) Solid height; (iii) Spring rate. [4M]

    b) 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/mm^2 and modulus of rigidity for the material of helical spring is 80 kN/mm^2. [10M]

Code No: R2031032 **R20** SET - 4

III B. Tech I Semester Regular Examinations, Dec/Jan – 2022-23
DESIGN OF MACHINE MEMBERS - I
(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

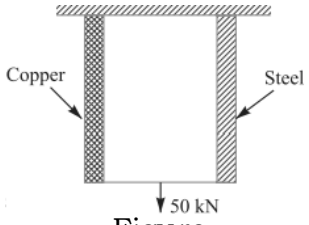
Answer any **FIVE** Questions **ONE** Question from **Each unit**
All Questions Carry Equal Marks
*****

UNIT-I

1. a) Define (i) Creep, (ii) Fatigue, (iii) Hardness, (iv)Resilience [7M]
   b) What is Limit? Discuss about basis of limit system [7M]

(OR)

2. a) A bar 3 m long is made of two bars shown in Figure, one of copper having E = 105 GN/m^2 and the other of steel having E = 300 GN/m^2. Each bar is 25 mm broad and 12.5 mm thick. This compound bar is stretched by a load of 50 kN. Find the increase in length of the compound bar and the stress produced in the steel and copper. The length of copper as well as of steel bar is 3 m each. [7M]



Figure

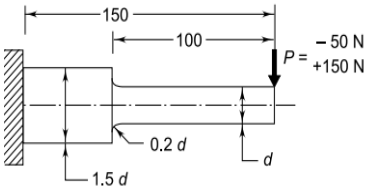
   b) What are the important theories of elastic failures? [7M]

UNIT-II

3. a) What is fatigue failure? Discuss about low cycle and high cycle fatigue. [7M]
   b) A forged steel bar, 50 mm in diameter, is subjected to a reversed bending stress of 250 N/mm^2. The bar is made of steel 40C8 (S_{ut} = 550 N/mm^2). Calculate the life of the bar for a reliability of 90%. The surface finish factor 0.44, and size factor 0.85. [7M]

(OR)

4. a) Explain the modified Goodman diagram for bending stresses. [7M]
   b) A cantilever beam made of cold drawn steel 4OC8 (S_{ut} = 600 N/mm^2 and S_{yt} = 380 N/mm^2) is shown in Figure. The force P acting at the free end varies from –50 N to +150 N. The expected reliability is 90% and the factor of safety is 2. The notch sensitivity factor at the fillet is 0.9. Determine the diameter 'd' of the beam at the fillet cross-section. The surface finish factor is 0.77, size factor is 0.85 and the theoretical stress concentration factor is 1.44. [7M]

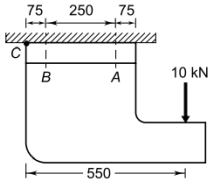


Figure

|'''|'|'|''|''||'|||

UNIT-III

5. a) A cast iron bracket, as shown in Figure, supports a load of 10 kN. It is fixed to the horizontal channel by means of four identical bolts, two at A and two at B. The bolts are made of steel 30C8 (S_{yt} = 400 N/mm^2) and the factor of safety is 6. Determine the major diameter of the bolts if (dc = 0.8d). [7M]

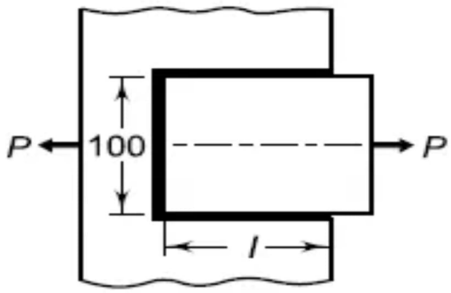


Figure

b) Briefly discuss about the strength of parallel fillet welds. [7M]

(OR)

6. a) A steel plate, 100 mm wide and 10 mm thick, is joined with another steel plate by means of single transverse and double parallel fillet welds, as shown in Figure. The strength of the welded joint should be equal to the strength of the plates to be joined. The permissible tensile and shear stresses for the weld material and the plates are 70 and 50 N/mm^2 respectively. Find the length of each parallel fillet weld. Assume the tensile force acting on the plates as static. [7M]



b) Discuss the design procedure of spigot and socket cotter joint. [7M]

UNIT-IV

7. a) Design of hallow shaft on strength basis. [7M]

b) A hollow transmission shaft, having inside diameter 0.6 times the outside diameter, is made of plain carbon steel 40C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 3. A belt pulley, 1000 mm in diameter, is mounted on the shaft, which overhangs the left hand bearing by 250 mm. The belts are vertical and transmit power to the machine shaft below the pulley. The tension on the tight and slack sides of the belt are 3 kN and 1 kN respectively, while the weight of the pulley is 500 N. The angle of wrap of the belt on the pulley is 180°. Calculate the outside and inside diameters of the shaft. [7M]

(OR)

8. a) Discuss about the design procedure for rigid flange coupling. [7M]

   b) It is required to design a split muff coupling to transmit 50 kW power at 120 rpm The shafts, key and clamping bolts are made of plain carbon steel 30C8 (S_{yt} = 400 N/mm^2). The yield strength in compression is 150% of the tensile yield strength. The factor of safety for shafts, key and bolts is 5. The number of clamping bolts is 8. The coefficient of friction between sleeve halves and the shaft is 0.3. (i) Calculate the diameter of the input and output shafts. (ii) Specify the length and outer diameter of the sleeve halves. (iii) Find out the diameter of clamping bolts assuming that the power is transmitted by friction. (iv) Specify bolt diameter using standard empirical relations. (v) Specify the size of key and check the dimensions for shear and compression criteria [7M]

UNIT-V

9. a) Briefly discuss about (i) Solid length, (ii) Compressed length and (iii) Free length [4M]

   b) An automotive engine develops maximum torque at a speed of 1000 rpm At this speed, the power developed by the engine is 25 kW. The engine is equipped with a single plate clutch having two pairs of friction surfaces. The mean diameter of the friction disk is 190 mm and the coefficient of friction is 0.35. Six springs, with a spring index of 6, provide the necessary axial force. The springs are made of patented and cold-drawn steel wires of Grade 2 (G = 81 370 N/mm^2). The permissible shear stress can be taken as 50% of the ultimate tensile strength. Determine the wire diameter of the spring. [10M]

(OR)

10. a) Distinguish between closely coiled and open coiled helical springs. [4M]

    b) A semi-elliptical laminated spring 900 mm long and 55 mm wide is held together at the centre by a band 50 mm wide. If the thickness of each leaf is 5 mm, find the number of leaves required to carry a load of 4500 N. Assume a maximum working stress of 490 MPa. If the two of these leaves extend the full length of the spring, find the deflection of the spring. The Young's modulus for the spring material may be taken as 210 kN/mm^2. [10M]