VTU B.E/B.TECH QUESTION PAPER SET

CBCS
SEMESTER V

DESIGN OF MACHINE ELEMENTS - I

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CBCS Scheme

USN | | | | | | | | | | 15ME54

Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 80

Note: 1. *Answer any FIVE full questions, choosing one full question from each module.*
2. *Use of design data hand book is allowed.*
3. *Assume suitable missing data.*

Module-1

1 a. Define standards and codes. **(04 Marks)**

b. A circular rod of diameter 50 mm is subjected to loads as shown in Fig.Q1(b). Determine the nature and magnitude of stresses at the critical points.

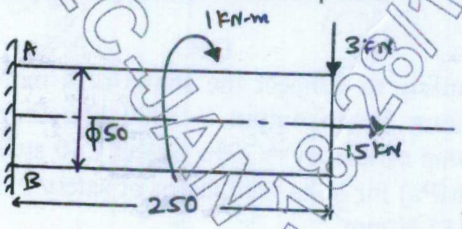

Fig.Q1(b) **(12 Marks)**

OR

2 a. Briefly explain the phases of design process (Shigley's). **(04 Marks)**

b. A flat bar shown in Fig.Q2(b) is subjected to an axial load of 100 kN. Assuming that the stress in the bar is limited to 200 N/mm^2, determine the thickness of bar.

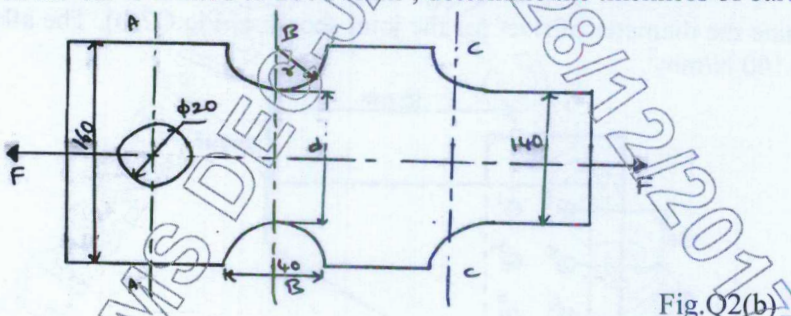

Fig.Q2(b) **(12 Marks)**

Module-2

3 a. A cantilever beam of span 800 mm has a rectangular cross section of depth 200 mm. The free end of the beam is subjected to a transverse load of 1 kN that drops on to it from a height of 40 mm. Selecting C40 steel (σ_y = 328.6 MPa) and FoS = 3, determine the width of rectangular cross section.

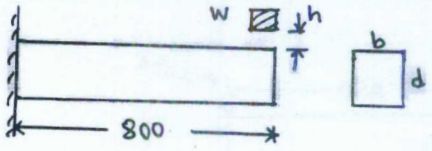

Fig.Q3(a) **(08 Marks)**

b. A rectangular cross section bar 200 mm long is subjected to an impact by a load of 1 kN that falls on to it from a height of 10 mm from rest. Determine the cross section dimension of rectangular bar, if the allowable stress of material of bar is 125 N/mm^2. Assume the thickness depth is twice width. Also find the deformation due to impact. **(08 Marks)**

OR

4 A round rod of diameter 1.2 d is reduced to a diameter 'd' with a fillet radius of 0.1 d. This stepped rod is to sustain a twisting moment that fluctuates between 2.5 kN-m to 1.5 kN-m together with a bending moment of +1 kN-m to −1 kN-m. The rod is made of carbon steel C40 (σ_y = 328.6 MPa; σu = 620 MPa). Determine suitable value for 'd'. **(16 Marks)**

Module-3

5 A solid steel shaft running at 600 rpm is supported on bearings 600 mm apart. The shaft receives 40 KW through a 400 mm diameter pulley weighing 400 N located 300 mm to the right of left bearing by a vertical flat belt drive. The power is transmitted from the shaft through another pulley of diameter 600 mm weighting 600 N located 200 mm to the right of right bearing. The belt drives are at right angles to each other and ratio of belt tension is 3. Determine the size of shaft necessary, if the allowable shear stress in the shaft material is 40 MPa and the loads are steady. **(16 Marks)**

OR

6 Design a flange coupling to connect the shafts of a motor and centrifugal pump for the following specifications: Pump output = 3000 liters/minute, total head = 20 m, pump speed = 600 rpm, pump efficiency = 70%. Select C40 steel (σ_y = 328.6 MPa) for shaft and C35 steel (σ_y = 304 MPa) for bolts with factor of safety 2. Use allowable shear stress in cast iron flanges equal to 15 N/mm^2. **(16 Marks)**

Module-4

7 a. A double riveted lap joint is to be made between 9 mm plates. If the safe working stresses in tension, crushing and shear are 80, 120 and 60 N/mm^2 respectively, design the riveted joint. **(08 Marks)**

b. Determine the diameter of rivet for the joint shown in Fig.Q7(b). The allowable stress in the rivet is 100 N/mm^2.

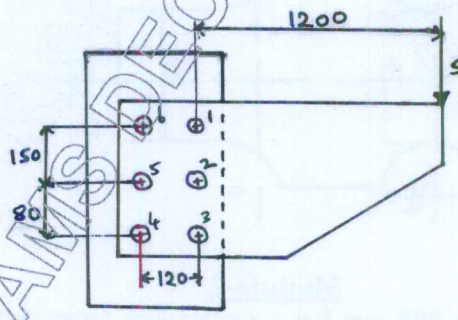

Fig.Q7(b) **(08 Marks)**

OR

8 a. A 16 mm thick plate is welded to a vertical support by two fillet welds as shown in Fig.Q8(a). Determine the size of weld, if the permissible shear stress for the weld material is 75 MPa.

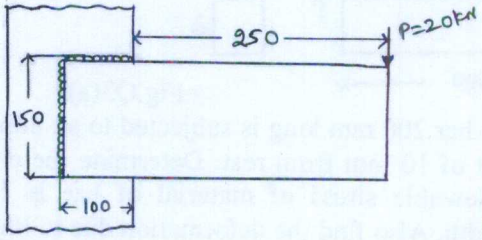

Fig.Q8(a) **(08 Marks)**

b. Determine the allowable stress in the joint shown in Fig.Q8(b), if size of weld is 10 mm.

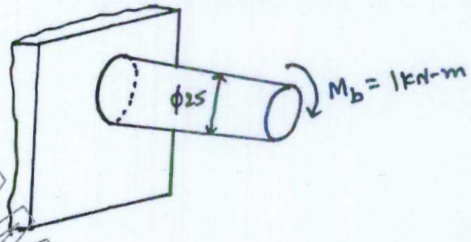

Fig.Q8(b) **(08 Marks)**

Module-5

9 a. The structure in Fig.Q9(a) is subjected to eccentric load P = 10 kN with eccentricity of 500 mm. All holts are identical mode of carbon steel having yield strength in tension is 400 MPa and factor of safety is 2.5. Determine size of bolt.

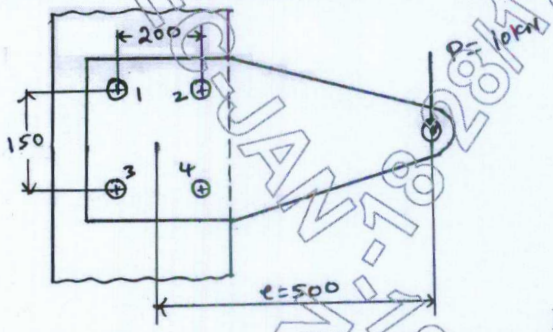

Fig.Q9(a) **(08 Marks)**

b. A bracket is fixed to wall by 4 bolts and loaded as shown in Fig.Q9(b). Calculate the size of bolts if the load is 10 kN and allowable shear stress in bolt material is 40 MPa.

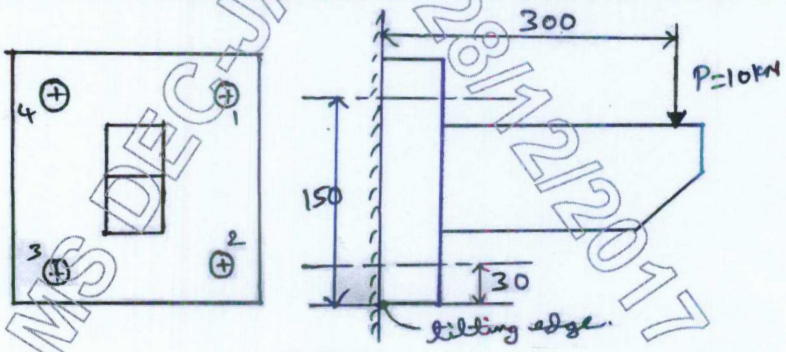

Fig.Q9(b) **(08 Marks)**

OR

10 Design a Screw Jack (complete design) with a lift of 300 mm to lift a load of 50 kN. Select C40 steel (σ_y = 328.6 MPa) for the screw and soft phosphor bronze (σ_{ut} = 345 MPa and σ_y = 138 MPa) for nut. **(16 Marks)**

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CBCS SCHEME

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15ME54

Fifth Semester B.E. Degree Examination, June/July 2018
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 80

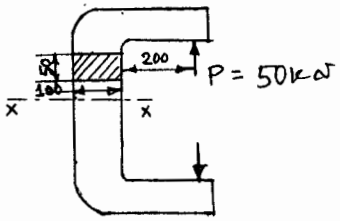
Note: 1. Answer any FIVE full questions, choosing one full question from each module.
2. Use of design data handbook is permitted.
3. Assume missing data, if any, suitably.

Module-1

1 a. Briefly explain the process of mechanical engineering design. **(03 Marks)**

b. Explain the importance of standards in design and list different standards used. **(03 Marks)**

c. Determine extreme fiber stresses at section x - x of the machine member loaded as shown in Fig.Q1(c). Also show the distribution of stresses at this section. **(10 Marks)**



All dimensions are in mm.

Fig.Q1(c)

OR

2 a. State and explain following theories of failure:
(i) Maximum normal stress theory
(ii) Maximum shear stress theory **(06 Marks)**

b. A shaft made of C40 steel is subjected to a bending moment of 10 kN-m and a twisting moment of 8 kN-m. Factor of safety used is 2.5. Determine the required diameter of the shaft according to :
(i) Maximum shear stress theory of failure
(ii) Maximum distortion energy theory of failure. **(10 Marks)**

Module-2

3 a. Derive Soderberg equation for designing members subjected to fatigue loading. **(06 Marks)**

b. Machine member is in the form of a simply supported beam of length 1 m and cross section 50mm × 60mm. It is made of steel having permissible stress of 120 MPa. Determine the safe height from which a mass of 10 kg may be allowed to fall at the midpoint of the beam. **(10 Marks)**

OR

4 A transmission shaft carries a gear midway between two bearings. The bending moment at the gear varies from – 300 N-m to +500 N-m, as the twisting moment varies from 100 N-m in c.w. direction to 200 N-m in c.c.w direction. The frequencies of variation of bending and torsional moments are equal to the shaft speed. The shaft is made of C30 steel. The endurance limit may be taken as 50% of ultimate strength. Determine the diameter of the shaft taking size factor as 0.85, surface finish factor as 0.88 and factor of safety of 2. **(16 Marks)**

Module-3

5 A power transmission shaft 1400 mm long is supported at its extreme ends. The shaft receives a power of 50 kW through a gear drive located 500 mm to the right of the left end of the shaft at a rated speed of 600 rpm. PCD of gear is 200 mm, pressure angle 20° and weight 500 N. This gear receives power from another gear directly behind. This power is delivered through a belt drive located a distance of 400 mm to the left of the right support. The belt pulley has a pitch diameter of 350 mm and weighs 800 N. The belt moving on the pulley is directed towards the observer, below the horizontal and inclined at 45° to it. The ratio of belt tensions is 3. Selecting carbon steel C40, factor of safety of 2.5 design the solid circular shaft consider the loading to have minor shocks. **(16 Marks)**

OR

6 a. A cast iron protected type flange coupling is used to connect two shafts of 80 mm diameter. The shaft runs at 300 rpm and transmits a power of 150 kW. The permissible shear stress for shaft and bolt materials is 50 MPa and permissible shear stress for flange is 10 MPa. design the coupling and draw the sketch. **(08 Marks)**

b. Design a knuckle joint for a tie rod of circular cross section to sustain a maximum tensile load of 75 kN. The material used for the joint has the following permissible stresses: 120 MPa in tension 80 MPa in shear and 180 MPa in crushing. **(08 Marks)**

Module-4

7 a. Design a double riveted double strap longitudinal butt joint with unequal straps for a pressure vessel. The ID of the pressure vessel is 1.2 m and vessel is subjected to an internal pressure of 2.5 MPa. The pitch of the rivet in the outer row is to be double the pitch in the inner row. The allowable tensile stress for the plate material is 120 MPa. The allowable shearing and crushing stress for rivet material are : 80 MPa and 170 MPa respectively. The strength of the rivet in double shear is to be taken as 1.875 times that in single shear. Assume efficiency of the joint as 85%. **(08 Marks)**

b. Determine the size of rivets required for the eccentrically loaded joint as shown in Fig.Q7(b). The allowable shear stress for the rivet material is 60 MPa. **(08 Marks)**

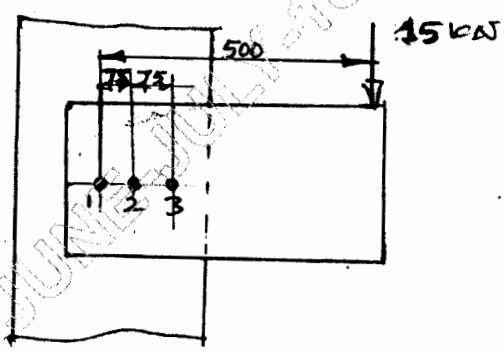


Fig.Q7(b)

OR

8 a. What are the advantages and disadvantages of welded joint over riveted joints? **(03 Marks)**

b. What is a 'Lozange' joint? Where is it used? **(03 Marks)**

c. Determine the size of the weld required for a flat plate welded to a steel column and loaded as shown in Fig.Q8(c). The permissible shear stress for the weld material is 70 MPa. **(10 Marks)**

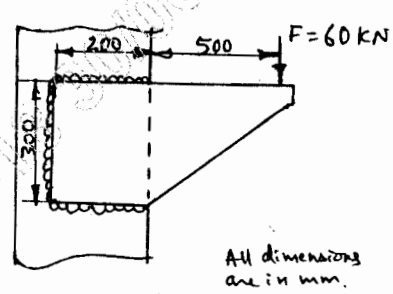


Fig.Q8(c)

Module-5

9 a. The cylinder head of a steam engine is subjected to a pressure of 0.6 MPa. It is held in position by means of 12 bolts. Each bolt is subjected to an initial tension of 5 kN. A soft copper gasket is used to make the joint leak proof. Effective diameter of the cylinder is 250 mm. Find the size of bolts so that the stress in the bolt is not to exceed 100 MPa. **(08 Marks)**

b. A bracket is fixed to the support using four bolts as shown in Fig.Q9(b). Select the suitable size for bolts if the allowable tensile stress in the bolts is 120 MPa. **(08 Marks)**

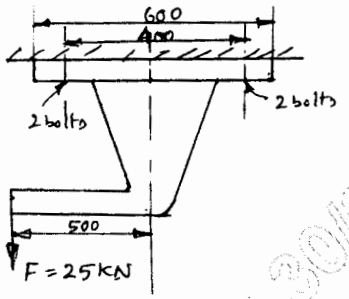


Fig.Q9(b)

OR

10 a. Explain self locking in power screws and its importance. **(03 Marks)**

b. A screw jack is to lift a load of 100 kN through a height of 400 mm. Screw is made of steel with allowable stresses of 100 MPa in tension and compression, 60 MPa in shear. The material for the nut in phosphor bronze for which the allowable stress in tension is 30 MPa, in compression it is 60 MPa and in shear 25 MPa. The bearing pressure between nut and screw is not to exceed 18 MPa. Design the screw and nut. Also check whether the screw is self locking. Take coefficient of friction between screw and nut threads as 0.14 and for collar 0.1. **(13 Marks)**

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CBCS SCHEME

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15ME54

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 80

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Any missing data may be suitably assumed.***
3. ***Use of design data hand book is permitted.***

Module-1

1 a. List the factors which govern the selection of appropriate material for a machine component. **(05 Marks)**

b. A stepped shaft with its diameter reduced for '2d' to 'd' has a fillet radius of 0.1d. Determine the diameters of the shaft and the radius of the fillet to transmit a power of 65 KW at a rated speed of 1440 rpm limiting the shear stress induced to 60 MPa. **(11 Marks)**

OR

2 a. Define stress concentration and show how stress concentration can be reduced for two examples with neat sketches. **(06 Marks)**

b. A cantilever beam of rectangular cross section with a depth of 150 mm is subjected to an axial tensile load of 40 kN and a transverse load of 50 kN acting downwards at the free end of 600 mm length beam. The material of the beam has allowable tensile stress of 100 MPa. Determine the width of rectangular section of the beam. **(10 Marks)**

Module-2

3 a. Derive an expression for impact stress induced in a member subjected to axial load. **(06 Marks)**

b. A piston rod of steam engine is subjected to a completely reversed axial load of 50 kN. The material of rod has an yield normal stress of 310 N/mm^2 and endurance stress of 289 N/mm^2. Assuming load factor of 0.7, size factor as 1 and surface finish factor as 1. Determine the diameter of rod. Choose factor of safety as 2. **(10 Marks)**

OR

4 a. Derive Soderberg's relation for a member subjected to fatigue loading. **(06 Marks)**

b. A beam of 400 mm depth I-section is resting on two supports 5m apart. It is loaded by a weight of 8 kN falling through a height of 20 mm and striking the beam at mid point. Moment of inertial of the section is 12×10^7 mm^4. Take $E = 2 \times 10^5$ N/mm^2. Determine:
i) Impact factor ii) Instantaneous maximum stress
iii) Instantaneous maximum deflection iv) Instantaneous maximum load. **(10 Marks)**

Module-3

5 A shaft mounted between bearings 1.2 m apart receives a power of 20 KW at 1000 rpm through a pulley 600 mm diameter located 400 mm from the left bearing from another pulley directly below it. The power is delivered through a pinion of 200 mm diameter located 700 mm from the left bearing to another gear in front of it. The shaft rotates clockwise when viewed through the left bearing. The belt has a ratio of tensions of 2.5 and the gears are of 20° pressure angle. The weight of the pulley is 500 N and that of the gear is 200 N. Determine the diameter of shaft. The material of the shaft has design shear stress of 60 MPa. Choose $K_b = 1.5$, $K_t = 1.0$. **(16 Marks)**

OR

6 a. Design a cotter joint to join two round rods capable of sustaining an axial load of 100 kN. The material of the joint has design tensile stress = 100 N/mm^2, crushing stress = 150 N/mm^2 and shear stress = 60 N/mm^2. **(08 Marks)**

b. A cast iron flange coupling is used to connect two shafts of 80 mm diameter. The shaft runs at 250 rpm and transmits a torque of 2500 N-m. The permissible shear stress for shaft material and bolt materials is 50 MPa and permissible shear stress for flange is 20 MPa. Design the bolts and the flange. Also select suitable key for the coupling. Take allowable normal stress for bolt as 100 MPa. **(08 Marks)**

Module-4

7 a. Design a double riveted butt joint with two cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume an efficiency of 72%, allowable tensile stress in the plate of 90 N/mm^2, crushing stress of 140 N/mm^2 and an allowable shear stress in the rivet of 50 N/mm^2. **(08 Marks)**

b. Determine the size of weld required for an eccentrically loaded weld as shown in Fig.Q7(b). The allowable stress in the weld is 75 MPa.

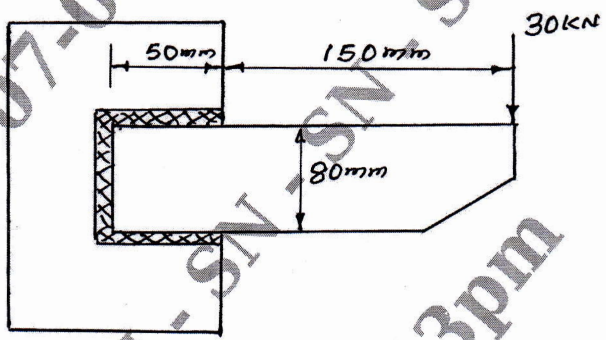

Fig.Q7(b) **(08 Marks)**

OR

8 a. Two lengths of a flat tie bar for a bridge structure of 250 mm wide and 18 mm thick are connected by a diamond joint with equal cover plates on either side. Design the joint completely working stresses for the material of the bar are 100 MPa in tension, 70 MPa in shear and 160 MPa in crushing. **(08 Marks)**

b. One end of a rectangular bar of cross section 120 mm × 70 mm is welded to a vertical support by four fillet welds along its circumference. A steady transverse load of 10 kN is applied at the free end of the bar of length 160 mm and is parallel to 120 mm side. Determine the size of weld, if the allowable stress in the material is limited to 115 MPa. **(08 Marks)**

Module-5

9 a. A bracket is fixed to the wall by means of four bolts and loaded as shown in Fig.Q9(a). Calculate the size of bolts if the load is 10 kN and allowable shear stress in the bolt material is 40 MPa.

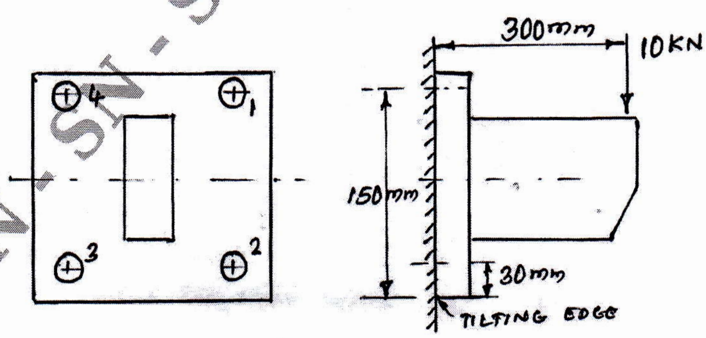

Fig.Q9(a) **(08 Marks)**

b. A square threaded power screw has a nominal diameter of 30 mm and a pitch of 6 mm with double threads. The load on the screw is 6 kN and the mean diameter of the thrust collar is 40 mm. the coefficient of friction for the screw is 0.1 and the collar is 0.09. Determine:
i) Torque required to raise and lower the screw with load
ii) Overall efficiency (08 Marks)

OR

10 A screw jack is to lift a load of 80 kN through a height of 400 mm ultimate strength of screw material in tension and compression is 200 N/mm^2 and in shear 120 N/mm^2. The material for the nut is phosphor bronze for which the ultimate strength is 100 N/mm^2 in tension and 90 N/mm^2 in compression and 80 N/mm^2 in shear. The bearing pressure between the nut and the screw is not to exceed 18 N/mm^2. Design the screw and nut and check for stresses. Take FOS = 2, μ = 0.14. Design jack for 25% overload. (16 Marks)

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CBCS SCHEME

USN | | | | | | | | | | **15ME54**

Fifth Semester B.E. Degree Examination, June/July 2019
Design of Machine Elements – I

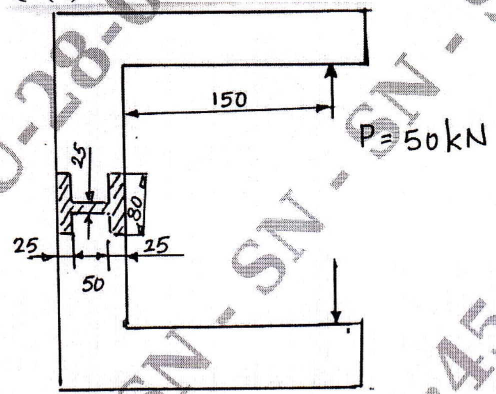
Time: 3 hrs. Max. Marks: 80

Note: 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Use of design data hand book is permitted.*
3. *Assume missing data, if any, suitably.*

Module-1

1 a. Briefly discuss the factors influencing the selection of suitable material for machine elements. **(04 Marks)**

b. Determine the extreme fibre stresses at the critical section of the machine member loaded as shown in Fig.Q1(b). Also show the distribution of stresses at this section. **(12 Marks)**



All dimensions are in mm.

Fig.Q1(b)

OR

2 a. Give any three examples of stress raisers and show how the stress concentration can be reduced in these cases. **(06 Marks)**

b. A machine element loaded as shown in Fig.Q2(b). Determine the safe value of thickness of the plate. Material selected for the machine element has an allowable stress of 200 MPa.

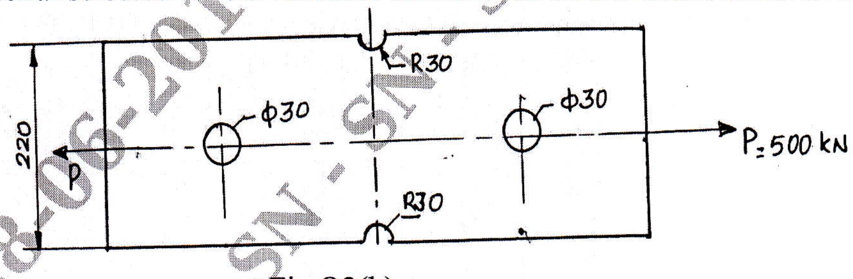


Fig.Q2(b) **(10 Marks)**

Module-2

3 a. Derive an expression for impact stress in a axial bar of c/s A and length 'L' due to the impact load of 'W' falling from a height 'h' from the collar. **(06 Marks)**

b. A steel cantilever beam of rectangular cross section is loaded 400 mm from the support. The width of the beam is 15 mm and depth is 20 mm. Determine the max bending stress in the beam, when a weight of 100 N is dropped on the beam through a height of 5 mm. Take E = 210 N/mm^2. **(06 Marks)**

c. Explain with neat sketches, the different types of varying stresses. **(04 Marks)**

OR

4 a. Derive Soderberg's design equation for members subjected to variable stresses. **(06 Marks)**

b. A hot rolled steel shaft is subjected to a torsional load varies from 330 Nm clockwise to 110 Nm counter, clockwise and an applied bending moment varies from +440 Nm to –220 Nm. Determine the required shaft diameter. The ultimate strength of the material is 550 MPa and yield stress is 410 MPa. Take factor of safety as 1.5, endurance limit as half the ultimate strength and size factor as 0.85. Neglect the effect of stress concentration. **(10 Marks)**

Module-3

5 A steel shaft (C45) transmitting 15 kW at 210 rpm is supported between two bearings 1000 mm apart. On this, two spur gears are mounted. The gear having 80 teeth of module 6 mm is located 100 mm to the left of the right bearing and receives power from a driving gear such that the tangential force acts vertical. The pinion having 24 teeth and 6 mm module located 200 mm to the right of the left bearing and delivers power to a gear mounted behind it. Taking combined shock and fatigue factors 1.75 in bending and 1.25 in torsion, determine the diameter of the shaft. **(16 Marks)**

OR

6 a. Design a socket and spigot type of cotter joint for an axial load of 50 kN which alternately changes from tensile to compressive, assuming allowable stresses in the components under tension and compression as 52.5 MPa, bearing stress as 63 MPa and shearing stress as 35 MPa. **(08 Marks)**

b. Design a protected type cast-iron flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted is 20% greater than the full load torque. The allowable shear stress in the bolt is 60 MPa and allowable shear stress in the flange is 40 MPa. **(08 Marks)**

Module-4

7 a. Design a double riveted butt joint to connect two plates of 20 mm thick. The joint is zig-zag riveted and has equal width cover plates. The allowable tensile stress for the plate is 100 MPa. The allowable shear and crushing stresses for rivet material are 60 MPa and 120 MPa respectively. Calculate the efficiency of the joint so that the joint should be leak proof. **(08 Marks)**

b. Determine the size of rivets required for the bracket shown in Fig.Q7(b). Take permissible shear stress for the rivet material as 100 MPa.

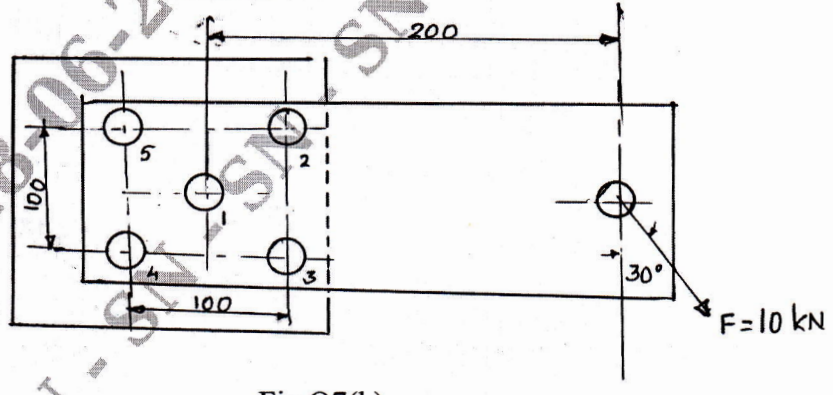


Fig.Q7(b) **(08 Marks)**

OR

8 a. A steel plate is welded by fillet weds to a structure and is loaded as shown in Fig.Q8(a). Calculate the size of the weld, if the load is 35 kN and allowable shear stress for the weld material is 90 MPa.

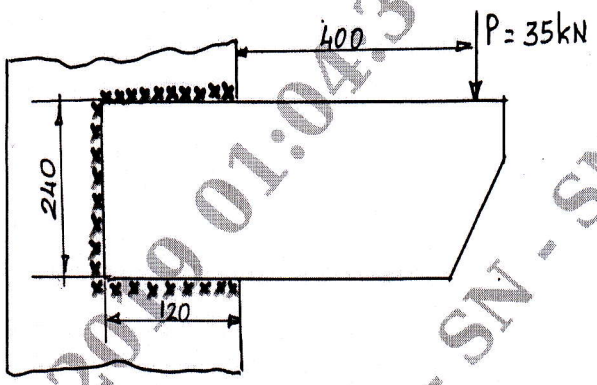


Fig.Q8(a) **(08 Marks)**

b. A circular beam, 50 mm in diameter is welded to a support by means of a fillet weld as shown in Fig.Q8(b). Determine the size of the weld, if the permissible shear stress in the weld is limited to 100 N/mm^2.

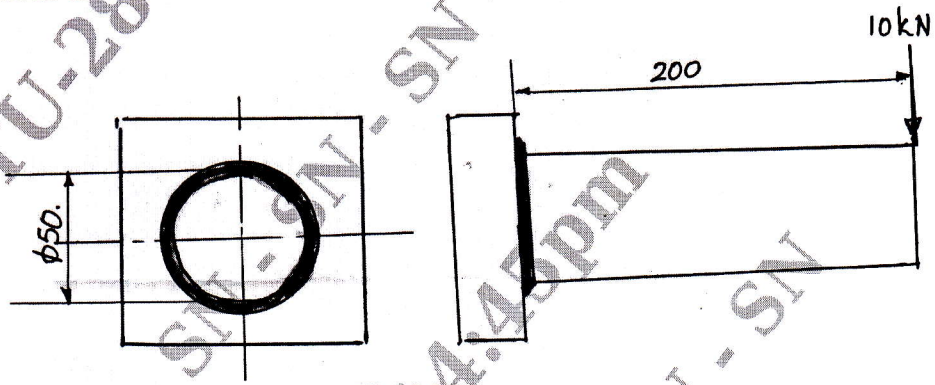


Fig.Q8(b) **(08 Marks)**

Module-5

9 a. Explain various types of stresses in threaded fasteners. **(04 Marks)**

b. A cylinder head is fastened to the cylinder of a compressor using 6 bolts of M20 size. Bolt material is C20 steel. The maximum fluid pressure is 3.5 MPa, cylinder diameter is 75 mm. A soft gasket is used. Assuming initial tension in each bolt is 40 kN, determine the factor of safety. **(12 Marks)**

OR

10 a. Derive an expression for torque required to lift the load on a square threaded screws. **(06 Marks)**

b. A square threaded power screw has a nominal diameter of 30 mm and a pitch of 6 mm with double start. Load on the screw is 6 kN and the mean diameter of the thrust collar is 40 mm. The coefficient of friction for screw is 0.1 and for collar is 0.09. Determine:

i) Torque required to rotate the screw against the load.
ii) Torque required to rotate the screw with the load.
iii) Overall efficiency.
iv) Is the screw self-locking? **(10 Marks)**

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CBCS SCHEME

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15ME54

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer FIVE full questions, choosing ONE full question from each module.***
2. ***Use of design data handbook is permitted.***
3. ***Missing data if any may be assumed.***

Module-1

1 a. What is mechanical engineering design? List the steps involved in design with a block diagram. **(04 Marks)**

b. A 50 mm diameter steel rod supports a load of 9 kN and in addition is subjected to a torsional moment of 100 N-m as shown in Fig. Q1 (b). Determine the maximum tensile and the maximum shear stress. **(08 Marks)**

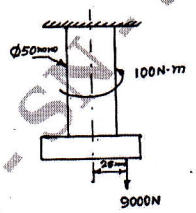

Fig. Q1 (b)

c. Explain the reasons for stress concentration in machine members and two methods adopted to reduce the same. **(04 Marks)**

OR

2 a. A machine element in the form of a Cantilever beam has a rectangular cross section of depth 200 mm. The beam is subjected to an axial tensile load of 60 KN and a transverse load of 50 KN acting downwards at the free end of the beam which has a span of 800 mm. Determine the width of rectangular cross section if the material of the beam is steel with an allowable tensile stress of 90 N/mm^2. (90 MPa) **(08 Marks)**

b. Determine the safe load that can be carried by a bar of rectangular cross section shown in Fig. Q2 (b) limiting the maximum normal stress to 130 MPa taking stress concentration into account. **(08 Marks)**

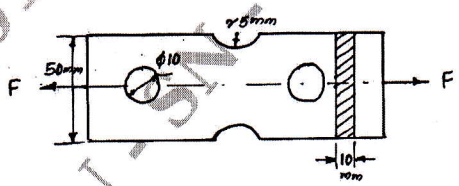

Fig. Q2 (b)

Module-2

3 a. Derive an expression for impact stress in an axial bar of cross section 'A' and length 'l' due to an impact load 'W' falling from a height 'h' on the bar. **(06 Marks)**

b. A Cantilever beam of rectangular cross section has a span of 800 mm. The rectangular cross section of the beam has a depth of 200 mm. The free end of the beam is subjected to a transverse load that fluctuates between 8 KN down to 5 KN up. The material for the beam is steel with an yield stress of 294 MPa, endurance strength of 275 MPa and factor of safety is 2.50. Determine the width of rectangular cross section taking surface finish factor as 0.95, size factor on 0.90 and stress concentration factor as 1.65. **(10 Marks)**

OR

4 a. Derive the Soderberg's equation for designing the members subjected to fatigue loading. **(06 Marks)**

b. A simply supported beam of span 1000 mm is subjected to a central load of 20 KN that falls from a height of 20 mm. The beam has a rectangular cross section of width 60 mm and depth 200 mm. The material of the beam has a modulus of elasticity of 207 GPa. Determine (i) Impact factor (ii) Instantaneous deflection (iii) Impact load. **(10 Marks)**

Module-3

5 a. Design a socket and spigot type cotter joint to sustain an axial load of 100 KN. The material selected for the joint has the following design stresses $\sigma_t = 80$ N/mm^2, $\tau = 60$ N/mm^2, $\sigma_C = 150$ N/mm^2. **(08 Marks)**

b. A cast iron flange coupling is used to connect two shafts of 80 mm diameter. The shaft runs at 250 rpm and transmits a torque of 4300 N-m. The permissible shear stress for bolt material is 50 MPa and permissible shear stress for flange is 8 MPa. Design bolts and the coupling. **(08 Marks)**

OR

6 A shaft mounted between bearings 1.2 m apart receives a power of 20 kW at 1000 rpm through a pulley 600 mm diameter located 400 mm from the left bearing from another pulley directly below it. The power is delivered through a gear of 200 mm diameter located 700 mm from the left bearing to another gear in front of it. The shaft rotates counterclockwise when viewed through the left bearing. The belt has a ratio of tensions of 2.5 and the gear is of 20° pressure angle. Determine the shaft diameter assuming the shaft to be made of steel with an yield shear stress of 180 MPa and factor of safety as 3. Take $K_b = 1.5$, $K_t = 1.0$. **(16 Marks)**

Module-4

7 a. Design a double riveted butt joint with equal width cover plates to join two plates of thickness 10 mm. The allowable stress for plate and rivets are $\sigma_t = 80$ MPa, $\tau = 60$ MPa and $\sigma_C = 120$MPa. **(08 Marks)**

b. Determine the size of weld required for an eccentrically loaded weld as shown in Fig. Q7 (b). The allowable stress in the weld is 75 MPa. **(08 Marks)**

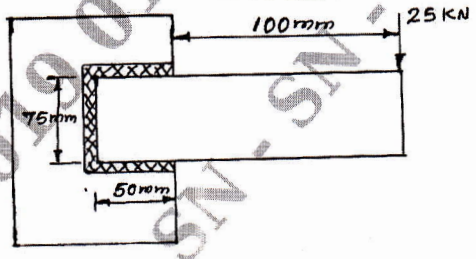

Fig. Q7 (b)

OR

8 a. Two lengths of a flat tie bar of 18 mm thick are connected by a butt joint with equal cover plates on either side. If a load of 400 KN is acting on the bar, design the joint such that the section of the bar is not weakened by more than one rivet hole. The working stresses for the material of the bar is 100 MPa in tension, for the material of the rivet 70 MPa in shear and 160 MPa in crushing. **(10 Marks)**

b. A plate of 80 mm wide and 15 mm thick is to be joined with another plate by a single transverse weld and a double parallel weld. Determine length of parallel weld if joint is subjected to static loading. Take $\sigma_t = 90$ MPa, $\tau = 55$ MPa an allowable stresses and stress concentration factor as 1.5 for transverse weld and 2.7 for parallel weld. **(06 Marks)**

Module-5

9 a. A cylinder head of a steam engine is subjected to a steam pressure of 0.8 MPa. It is held in position by means of 12 bolts. A soft copper gasket is used to make the joint leak proof. The bore diameter of the cylinder is 250 mm. Find the size of bolts so that the stress in bolts is not to exceed 110 MPa. **(08 Marks)**

b. The lead screw of a lathe has single start ISO trapezoidal threads of 30 mm outside diameter and 6 mm pitch. It drives a tool carriage and exerts an axial load of 1.5 KN on a thrust collar of 30 mm inside diameter and 50 mm outside diameter. If the lead screw rotates at 40 rpm, find the power required to drive the screw. Take coefficient of friction for power screw as 0.14 and for collar as 0.09. **(08 Marks)**

OR

10 a. Explain the stresses induced in a screw fastening subjected to static and impact loading. **(06 Marks)**

b. A power screw for a Jack has square threads of proportion $50 \times 42 \times 8$. The coefficient of friction at the threads is 0.1 and at the collar is 0.12. Determine the weight that can be lifted by this jack through a human effort of 400 N, through a hand lever of span 400 mm. **(10 Marks)**

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CBCS SCHEME

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15ME54

Fifth Semester B.E. Degree Examination, Aug./Sept.2020
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 80

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Design Data handbook is permitted.***

Module-1

1 a. Draw the stress strain diagram for a ductile material and briefly explain the salient points. **(06 Marks)**

b. What are the factors to be considered for the selection of material for a machine component? **(06 Marks)**

c. Explain the codes and standards used in machine design. **(04 Marks)**

OR

2 a. Define stress concentration. Briefly explain the factors effecting stress concentration. **(06 Marks)**

b. A round rod of diameter 1.2d has semicircular groove of diameter 0.2d. The rod is subjected to a bending moment of 10 kN-m. The material of the rod is C30 steel ($\sigma_y = 294$ N/mm^2). Determine the safe value of 'd'. If the factor of safety = 2. **(10 Marks)**

Module-2

3 a. Derive an expression for instantaneous stress due to axial impact. **(06 Marks)**

b. A cantilever beam of width 50 mm, depth 150 mm is 1.5m long. It is struck by a weight of 1000 N that falls from a height of 10 mm at its free end. Determine impact factor, instantaneous maximum deflection, instantaneous maximum stress, instantaneous maximum load. Take E = 206 GPa. **(10 Marks)**

OR

4 A steel cantilever member shown in Fig.Q4 is subjected to a transverse load at its end that varies from 45N (up) to 135N (down) and axial load varies from 110 N (compression) to 450 N (tension). Determine the required diameter at the change of section for infinite life using a factor of safety 2. The strength properties of the material are $\sigma_u = 550$ MPa, $\sigma_y = 470$ MPa, $\sigma_{-1} = 275$ MPa, notch sensitivity index, q = 1.

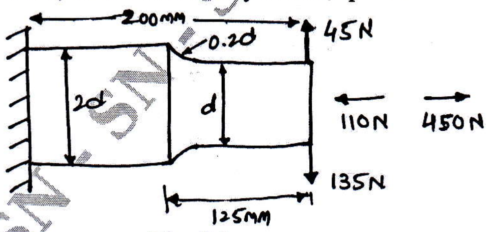

Fig.Q4 **(16 Marks)**

Module-3

5 A mild steel shaft transmits 20 KW at 200 rpm. It carries a central load of 900 N and is simply supported between the bearings 2.5 m apart. Determine the size of the shaft, if the allowable shear stress is 42 MPa and the maximum tensile or compressive stress is not to exceed 56 MPa. What size of the shaft will be required, if it is subjected to gradually applied loads? **(16 Marks)**

OR

6 a. Design a knuckle joint to connect two circular rods subjected to an axial tensile force of 50 kN. The rods are co-axial and a small amount of angular movement between their axes is permissible. The design stresses may be taken as 80 N/mm^2 in tension, 40 N/mm^2 in shear and 80 N/mm^2 in compression. **(08 Marks)**

b. Design a flange coupling to connect the shaft of a motor and centrifugal pump for the following specifications: pump output = 3000 liters/minute, total head = 20 m, pump speed = 600 rpm, pump efficiency = 70%. Select C40 steel (σy = 328.6 MPa) for shaft and C35 steel (σ_y = 304 MPa) for bolts with factor of safety 2. Use allowable shear stress in cast iron flanges equal to 15 N/mm^2. **(08 Marks)**

Module-4

7 a. Briefly explain the types of failure in riveted joints. **(04 Marks)**

b. Design a double riveted butt joint with two cover plates for longitudinal beam of a boiler shell 1.5 m in diameter subjected to steam pressure of 0.95 N/mm^2. Assume joint efficiency as 75%, allowable tensile stress is 90 N/mm^2, crushing stress is 140 N/mm^2 and shear stress is 56 N/mm^2. **(12 Marks)**

OR

8 a. A solid circular shaft 25 mm in diameter is welded to a support by means of a fillet weld as shown in Fig.Q8(a). Determine the leg dimensions of the weld if the permissible shear stress is 95 N/mm^2.

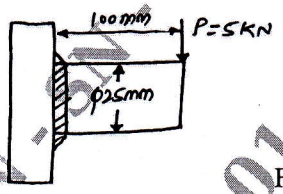

Fig.Q8(a) **(06 Marks)**

b. A bracket is welded to a side column as shown in Fig.Q8(b) with a permissible stress of 80 N/mm^2. Determine the maximum load that the bracket can withstand if the size of the weld is 10 mm.

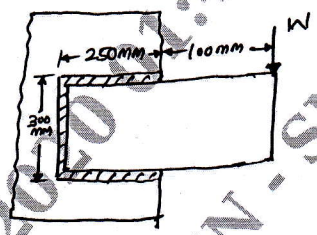

Fig.Q8(b) **(10 Marks)**

Module-5

9 a. Explain the various type of stresses in thread fasteners. **(06 Marks)**

b. A flat circular plate is used to close the flanged end of a pressure vessel of internal diameter 300 mm. The vessel carries a fluid at a pressure of 0.7 N/mm^2. A soft copper gasket is used to make the joint leak proof. Twelve bolts are used to fasten the cover plate onto the pressure vessel. Find the size of bolts so that the stress in the bolts is not to exceed 100 N/mm^2. **(10 Marks)**

OR

10 a. Derive an expression for torque required to lift the load on square threaded screw. **(06 Marks)**

b. A machine slide weighing 20 kN is raised by a double start square threaded screw at the rate of 0.84 m/min. The coefficient of friction for screw and collar is 0.12 and 0.14 respectively. The outside diameter of the screw is 44 mm and pitch is 7 mm. The outside and inside diameters of the collar at the end of the screw are 58 mm and 32 mm respectively. Calculate the power required to drive the slide and efficiency. If the allowable shear stress in the screw is 30 MPa, is the screw strong enough to sustain the load. **(10 Marks)**

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17ME54

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 100

Note:1. ***Answer FIVE full questions, choosing one full question from each module.***
2. Use of design data hand book permitted.

Module-1

1 a. With flow diagram, explain the phases of design. **(05 Marks)**

b. List and explain the factors to be considered for selection of material for a machine component. **(05 Marks)**

c. A point in a structural member is subjected to plane stress as shown in Fig. Q1 (c). Determine the following :
(i) Normal and tangential stress on a plane inclined at 45°.
(ii) Principal stresses and directions.
(iii) Maximum shear stress. **(10 Marks)**

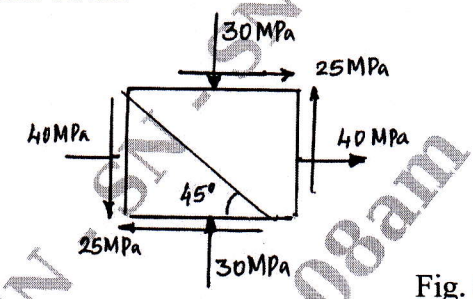

Fig. Q1 (c)

OR

2 a. What is stress concentration? Explain with neat sketches any three methods to reduce stress concentration in machine elements. **(05 Marks)**

b. A round shaft made of Grey Cast Iron FG200 with σ_{ut} = 200 MPa, is subjected to a bending moment of 15 N.m is as shown in Fig. Q2 (b). The theoretical stress concentration factor at fillet is 1.5. Determine the diameter 'd' and max stress at the fillet. **(05 Marks)**

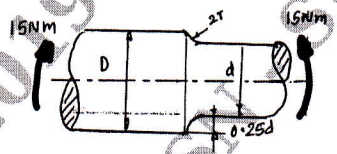

Fig. Q2 (b)

c. A 50 mm steel rod supports a 9 kN load in addition to this a torsional moment of 100 N.m is applied on it as shown in Fig. Q2 (c). Determine the maximum tensile and maximum shear stresses. **(10 Marks)**

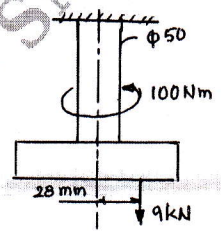

Fig. Q2 (c)

Module-2

3 a. Explain with sketches, the different types of varying stresses. **(05 Marks)**

b. Derive Soderberg equation for designing members subjected to fatigue loading. **(05 Marks)**

c. A steel cantilever beam is 200 mm long. It is subjected to an axial load varies from 150 N (compression) to 450 N (tension) and a transverse load at its free and which varies from 80 N (up) to 120 N (down). The Cantilever beam is of circular cross section having a diameter of 2 d for the first 50 mm and diameter 'd' for the remaining length. Determine its diameter using the following data. Use Soderberg equation.
Factor of safety = 2 ; Yield stress = 330 MPa; Endurance limit = 300 MPa
Stress concentration factor = 1.44 for bending,
1.64 for axial loading,
load correction factor = 0.7 for axial loading
1 for bending
Size correction factor = 0.85; Notch sensitivity = 0.9
Surface correction factor = 0.9 **(10 Marks)**

OR

4 a. Derive an expression for impact stress induced in a member subjected to axial load. **(05 Marks)**

b. Design a rod of solid circular cross section of length 200 mm (placed vertical) to sustain an axial compressive load of 1000 N, that falls on it from a height of 10 mm. The material selected has a design stress of 80 N/mm^2 and Young's modulus = 2.1×10^5 N/mm^2. **(05 Marks)**

c. A mass of 500 kg is being lowered by means of a steel wire rope having cross sectional area 250 mm^2. The velocity of the weight is 0.5 m/s, when the length of the extended rope is 20 m, the sheave gets stuck up. Determine the stress induced in the rope due to sudden stoppage of the sheave. Neglect friction. Take E = 190 GPa. **(10 Marks)**

Module-3

5 A commercial steel shaft with allowable shear stress 40 MPa. With shock factors for bending and twisting is 1.5 and 1 respectively. The length of the shaft between bearings is 600 mm, carries a pulley of 400 mm dia meter having weight 400 N, mounted in middle of the shaft. Shaft receives 40 kW at 600 rpm by a flat belt drive. Power from motor shaft is transmitted through another pulley of diameter 600 mm weighing 600 N overhanging the right hand bearing by 200 mm. The belt drives on pulleys are right angles to each other. Take ratios of belt tensions as 3, determine the diameter of the shaft. Use ASME code for shaft design. **(20 Marks)**

OR

6 a. Design a protected type CI flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key materials 40 MPa. The maximum torque transmitted is 20% greater than full load torque. The allowable shear stress in the bolt is 60 MPa and allowable shear stress in the flange is 40 MPa. **(10 Marks)**

b. Design a socket and spigot type of cotter joint to connect two rods subjected to steady axial pull of 100 kN. The material used for socket end, spigot end and cotter is cast steel with $\sigma_y = 328.6$ MPa, take FoS as 4 for tension, 6 for shear and 3 for crushing based on tensile yield strength. **(10 Marks)**

Module-4

7 a. Design a triple riveted longitudinal double strap butt joint with unequal strap for a boiler. The inside diameter of the longest course of the drum is 1.3 m. The joint is to be designed for a steam pressure of 2.4 N/mm^2. The working stresses to be used are $\sigma_t = 77$ MPa for plate material in tension, $\tau = 62$ MPa for rivet material in shear, $\sigma_C = 120$ MPa for rivet material in compression. Assume joint efficiency as 81%. **(10 Marks)**

b. Determine the size of rivets required for the bracket shown in Fig. Q7 (b). Take permissible shear stress for the rivet material as 100 MPa. **(10 Marks)**

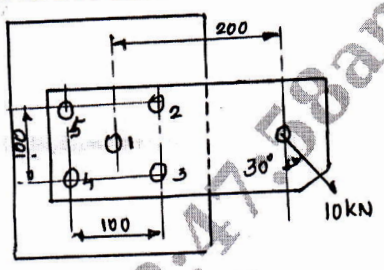

Fig. Q7 (b)

OR

8 a. The following Fig. Q8 (a) shows connections of eccentrically loaded welded joint. The allowable shear stress in the fillet weld using MS bar electrodes can be taken as 80 N/mm^2, find the thickness of the plate. **(10 Marks)**

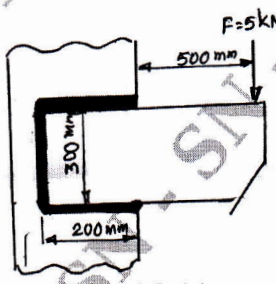

Fig. Q8 (a)

b. A shaft of rectangular cross section is welded to a support by means of fillet welds as shown in Fig. Q8 (b). Determine the size of the weld if the permissible shear stress in the weld material is 75 MPa. **(10 Marks)**

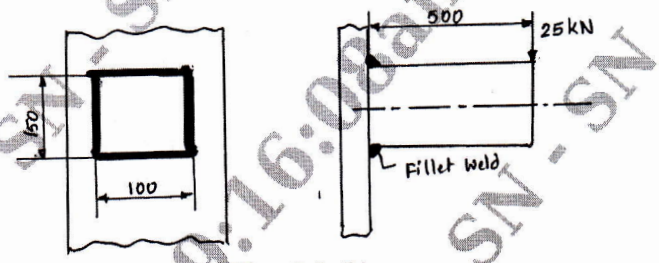

Fig. Q8 (b)

Module-5

9 a. A cylinder head is fastened to the cylinder of a compressor using 6 bolts of M20 size. Bolt material is C20 steel. The maximum fluid pressure is 3.5 MPa, cylinder diameter is 75 mm. A soft gasket is used. Assuming the initial tension required in each bolt is 40 kN, determine the factor of safety. **(10 Marks)**

b. In a hand vice, the screw has double start Acme thread of 25 mm internal diameter and 4 mm pitch. If the length of the lever is 300 mm; the maximum force that can be applied at the end of the lever is 250 N. Determine the force with which the job is held between the jaws of the vice. Take co-efficient of friction at the thread is 0.14, angle of thread $2\theta = 29^\circ$. Neglect collar friction. **(10 Marks)**

OR

10 a. Explain self locking and overhauling. Derive an expression for torque required to lift the load on square threaded screw. **(10 Marks)**

b. A single threaded power screw of 25 mm diameter with a pitch of 5 mm, a vertical load on the screw reaches a maximum load of 500 N. The co-efficients of friction are 0.05 for the collar and 0.08 for the screw. The frictional diameter of the collar is 30 mm. Find the torque required to rise and lower the load. Also find the efficiency of the power screw. **(10 Marks)**

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CBCS SCHEME

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17ME54

Fifth Semester B.E. Degree Examination, Aug./Sept.2020
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Any missing data may be suitably assumed.
3. Use of design data hand book is permitted.

Module-1

1 a. Explain the phases of design process. **(06 Marks)**

b. What is stress concentration? Mention the reasons for stress concentration. **(04 Marks)**

c. A C-clamp shown in Fig.Q1(c) carries a load of 25 kN. The cross-section of the clamp is rectangular and the ratio of depth to width (d/b) is 2:1. The clamp is made of cast steel of grade 20-40 (σ_y = 400 N/mm^2) and the factor of safety is 4. Determine the dimension of the cross section of the clamp.

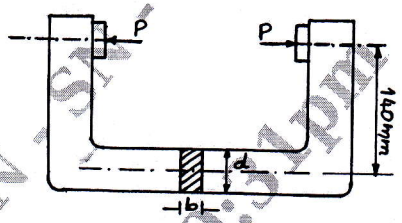

Fig.Q1(c) **(10 Marks)**

OR

2 a. Define factor of safety. **(02 Marks)**

b. Mention the principal theories of elastic failures and explain any two. **(08 Marks)**

c. A flat plate as shown in Fig.Q2(c) is subjected to a tensile force of 10 kN. The plate material is grey cast iron FG200 (σ_u = 200 N/mm^2) and factor of safety is 2.5. Determine the thickness of the plate.

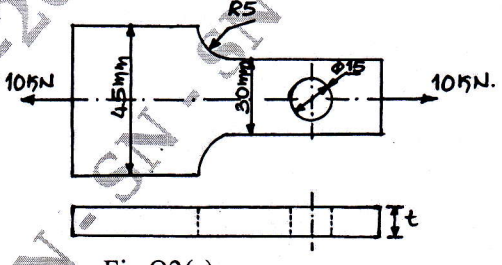

Fig.Q2(c) **(10 Marks)**

Module-2

3 a. Derive an expression for impact stress induced in a member subjected to bending. **(06 Marks)**

b. Define the following :
(i) Fatigue load (ii) Range of stress
(iii) Amplitude ratio (iv) Endurance Limit **(04 Marks)**

c. A weight of 1 kN is dropped from a height of 50 mm at the free end of a cantilever beam of effective length of 800 mm, selecting C40 steel (σ_y = 324 N/mm^2) and factor of safety 3. Determine (i) Cross-section of the cantilever beam of square cross-section (ii) Impact factor. Assume modulus of elasticity as 200 GPa. **(10 Marks)**

OR

4 a. Explain the factors affecting endurance limit. **(08 Marks)**

b. A steel shaft is subjected to a bending moment varies from 100 N-m to 200 N-m and transmit 10 kW at 150 rpm. The torque varies over a range of ±40%. The shaft is made of steel whose yield stress is 400 N/mm^2 and endurance stress 300 N/mm^2. Surface coefficient factor 0.9, size factor 1.2, factor of safety 5, stress concentration factor 1.94. Determine the diameter of shaft for infinite life. **(12 Marks)**

Module-3

5 A horizontal commercial shaft is supported by two bearings 1.5m apart. A keyed gear 20° involute and 175mm diameter is located 400mm to the left of the right bearing and is driven by a gear directly behind it. A 600mm diameter pulley is keyed to the shaft 600mm to the right of the left bearing and drives a pulley with a horizontal belt drive directly behind it. The ratio of tension of the belt is 3:1, with the slack side on top. The drive transmit 45 kW at 330 rpm. Take $C_m(k_b) = C_t(k_t) = 1.5$. Calculate the necessary diameter of the shaft. Use allowable shear stress of 40 MPa **(20 Marks)**

OR

6 a. What is Cotter? Mention the different types of Cotter Joint. **(04 Marks)**

b. Design a square key for fixing a gear on a shaft of 25mm diameter. The shaft is transmitting 15 kW power at 720 rpm to the gear. The key is made of steel 50C4 (σ_y = 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 dimension of the key. **(06 Marks)**

c. Design a rigid type of flange coupling to connect two shafts. The input shaft transmit 37.5 kW power at 180 rpm to the output shaft through the coupling. The design torque is 1.5 times rated torque. The shaft and keys are made of steel with yield strength of 380 N/mm^2 with factor of safety 2.5. flanges are made of grey cast iron FG200 with factor of safety 6. Assume ultimate shear strength is one half of the ultimate tensile strength. **(10 Marks)**

Module-4

7 a. Design a triple riveted lap joint zig-zag type, for a pressure vessel of 1.5m diameter. The maximum pressure inside the vessel is 1.5 MPa. The allowable stresses in tension, crushing and shear are 100 MPa, 125 MPa and 75 MPa respectively. **(10 Marks)**

b. Determine the size of the weld required for an eccentrically loaded weld as shown in Fig.Q7(b). The allowable stress in the weld is 75 N/mm^2.

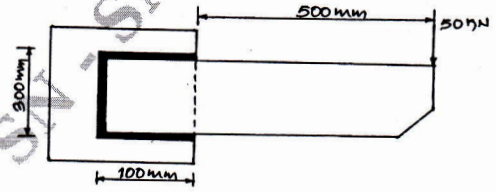

Fig.Q7(b) **(10 Marks)**

OR

8 a. A tie bar bridge consists of a flat 350 mm wide and 20 mm thick. Design an economical double cover butt joint if the permissible stresses are σ_t = 90 N/mm^2, σ_c = 150 N/mm^2 and τ = 60 N/mm^2. **(16 Marks)**

b. Two plates are joined by means of fillet weld as shown in Fig.Q8(b). The leg dimension of the weld is 10mm and the permissible shear at the throat cross-section is 75 N/mm^2. Determine the length of each weld. **(04 Marks)**

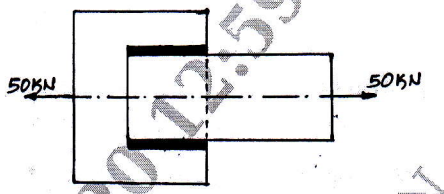

Fig.Q8(b)

Module-5

9 a. The base of a Pillar crane is fastened to the foundation by 8 bolts spaced equally on bolt circle diameter 1.6m. The diameter of the pillar base is 2m. Determine the size of bolt when crane carries a load of 100 kN at a distance of 5m from the centre of the base as shown in Fig.Q9(a). The allowable stress for the bolt material is 100 MPa.

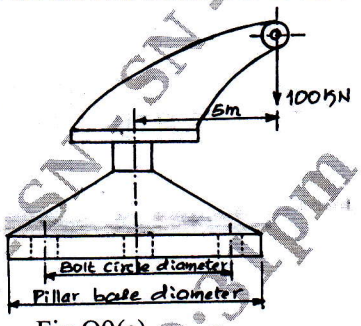

Fig.Q9(a) **(05 Marks)**

b. The square thread of a screw jack with a specification of 80×16, with a double start is to raise a load of 100 kN. The mean collar diameter is 130mm. The coefficient of friction for the threads and the collar are 0.1 and 0.12 respectively. Determine
(i) Torque required to raise the load.
(ii) Torque required to lower the load
(iii) Efficiency of the screw.
(iv) Check for overhaul. **(15 Marks)**

OR

10 a. Explain self locking and overhauling in power screw. **(04 Marks)**

b. Obtain the expression the torque required to lift the load in a square threaded screw. **(06 Marks)**

c. The joint shown in Fig.Q10(c) is subjected to an eccentric load of 40 kN. The bolts are made of plain carbon steel having yield strength in tension of 400 MPa and the factor of safety is 2.5. Determine size of bolts.

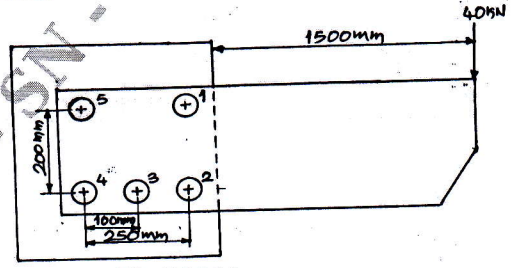

Fig.Q10(c) **(10 Marks)**

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