BACHELOR OF TECHNOLOGY (C.B.C.S.) (2020 COURSE)
B.Tech.Sem - IV MECHANICAL :SUMMER- 2022
SUBJECT : MACHINE DESIGN & ANALYSIS-I

Day : Thursday | Time : 10:00 AM 2:00 P.M.
Date : 16-06-2022 | **S-24497-2022** | Max. Marks : 60

N. B. :

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.
3) Draw neat and labelled diagrams **WHEREVER** necessary.
4) Use of non-programmable calculator is **ALLOWED**.
5) Assume suitable data, if necessary.

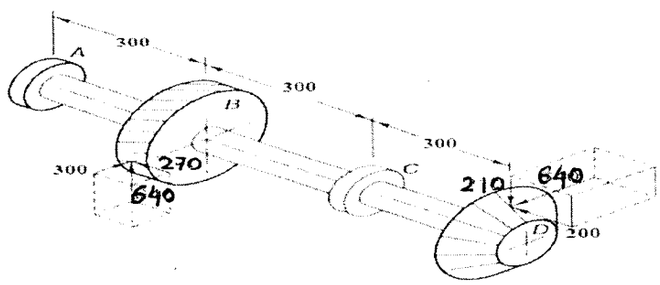
Q. 1 List the steps involved in design of machine components. Select any one of the mechanical component and apply these steps in details. **(10)**

OR

It is required to design a cotter joint to connect two steel rods of equal diameter. Each rod is subjected to an axial tensile force of 60 kN. Design the joint and specify its main dimensions. **(10)**

Take material for cotter as $30C8(S_{yt} = 450\,N/mm^2)$ and factor of safety 6.

Q. 2 A transmission shaft supporting a helical gear B and an overhung bevel gear D is shown in fig. The shaft is mounted on two bearings, A and C. The pitch circle diameter of the helical gear is 500 mm and the diameter of the bevel gear at the forces is 400 mm. Power is transmitted from the helical gear to the bevel gear. The gears are keyed to the shaft. The material of the shaft is steel $40C8(Sut = 580$ and $Syt = 400\ N/mm^2)$. The factors kb and kt of ASME code are 2.0 and 1.5 respectively. Determine the shaft diameter using the ASME code. **(10)**



OR

It is required to design a rigid type of flange coupling to connect two shafts. The input shaft transmits 40 kW power at 200 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. Design the coupling and specify the dimensions of its components. The shafts is made of plain carbon steel of grade $45C8(Syt = 450\ N/mm^2)$ is used for the shaft. The factor of safety for the shafts is assumed to be 2.5. The keys is made of plain carbon steel of grade $30C8(Syt = 400\ N/mm^2)$. It is assumed that the compressive yield strength is 150 % of the tensile yield strength. The factor of safety for the keys and the bolts is taken as 2.5. Flanges material is Grey cast iron $FG200(Sut = 250\,N/mm^2)$. It is assumed that ultimate shear strength is one half of the ultimate tensile strength. The factor of safety as 6. **(10)**

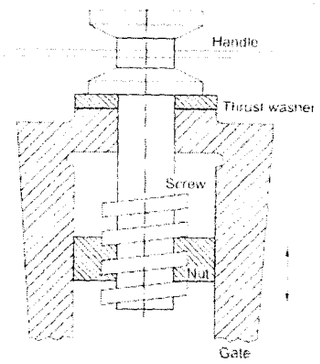
P. T. O.

Shaft diameter	No. of Bolts	Shaft diameter	Key dimension	Shaft diameter	Key dimension
$d < 40$	2	38 – 44	12 × 8	58 – 65	18 × 11
$40 < d < 100$	4	44 – 50	14 × 9	65 – 75	20 × 12
		50 – 58	16 × 10	75 – 85	22 × 14

Q. 3 The construction of a gate valve used in high pressure pipeline is shown in fig. The screw is rotated in its place by means of the handle. The nut is fixed to the gate. When the screw rotates, the nut along with the gate moves downward or upward depending upon the direction of rotation of the screw. The screw has single-start square threads of 40 mm outer diameter and 7 mm pitch. The weight of the gate is 4.5 kN. The water pressure in the pipeline induces frictional resistance between the gate and its seat. The resultant frictional resistance in the axial direction is 1.5 kN. The inner and outer diameters of thrust washer are 50 and 80 mm respectively. The values of coefficient of friction at the threads and at the washer are 0.15 and 0.12 respectively. The handle is rotated by the two arms, each exerting equal force at a radius of 600 mm from the axis of the screw. **(10)**

Calculate:

i) The maximum force exerted by each arm when the gate is being raised.
ii) The maximum force exerted by each are when the gate is being lowered.
iii) The efficiency of the gate mechanism.
iv) The length of the nut, if the permissible bearing pressure is $5 N / mm^2$.



OR

Explain Nipping of leaf spring. A semi-elliptic leaf spring used for automobile suspension consists of three extra full-length leaves and 20 graduated-length leaves, including the master leaf. The centre-to-centre distance between two eyes of the spring is 1 m. The maximum force that can act on the spring is 80kN. For each leaf, the ratio of width to thickness is 9.1. The modulus of elasticity of the leaf material is $210\,000 N / mm^2$. The leaves are pre-stressed in such a way that when the force is maximum, the stresses induced in all leaves are same and equal to $480 N / mm^2$. **(10)**

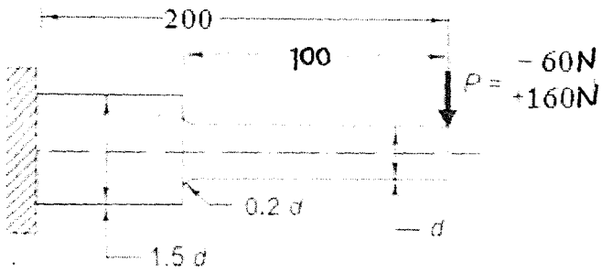
Determine:

i) The width and thickness of the leaves
ii) The initial nip
iii) The initial pre-load required to close the gap C between extra full-length leaves and graduated- length leaves.

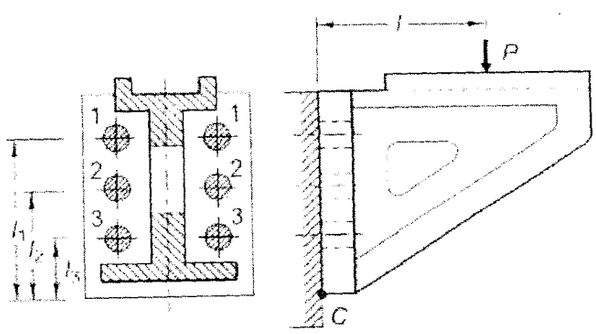
Q. 4 What is stress concentration? Reasons of stress concentration? Explain any one of the method to reduce stress concentration. **(10)**

OR

Explain the modified Goodman diagram. A cantilever beam made of cold drawn steel $40C8 (Sut = 650 N/mm^2$ *and* $Syt = 400 N/mm^2)$ is shown in fig. The force P acting at the free end varies from $-60\,N$ to $+160\,N$. 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. Take Ka = 0.80, $Kb = 0.85$ for 90% reliability, $Kc = 0.897$ and $Kt = 1.50$. **(10)**

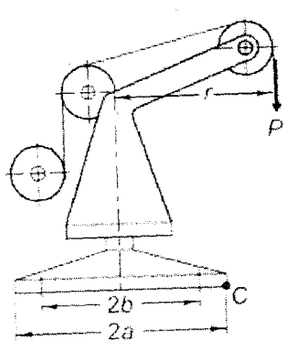


Q. 5 A bracket is fastened to the steel structure by means of six identical bolts as shown in fig. Assume the following data: $l_1 = 250\,mm$, $l_2 = 180\,mm$, $l_3 = 100\,mm$, $l = 200\,mm$, $P = 55\,kN$ Neglecting shear stress, determine the size of the bolts, if the maximum permissible tensile stress in any bolt is limited to $110\ N/mm^2$. **(10)**

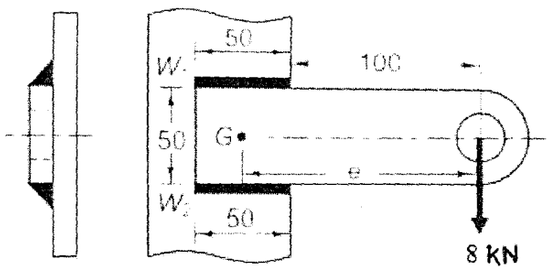


OR

A pillar crane, shown in fig. is fastened to the foundation by means of 16 identical bolts spaced equally on 1.9 m pitch circle diameter. The diameter of the pillar flange is 2.5 m. Determine the size of the bolts if a load of 60 kN acts at a radius of 8 m from the axis of the crane. The maximum permissible tensile stress in the bolt is limited to $85\,N/mm^2$. **(10)**

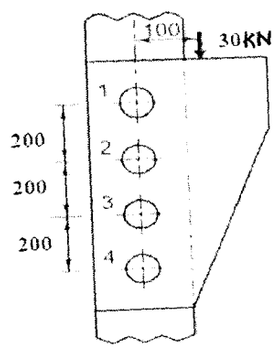


Q. 6 A welded connection, as shown in fig. is subjected to an eccentric force of 8 kN. Determine the size of the welds if the permissible shear stress for the weld is 120 N/mm^2. Assume static conditions. **(10)**



OR

A bracket, attached to a vertical column by means of four identical rivets, is subjected to an eccentric force of 30 kN as shown in fig. Determine the diameter of rivets, if the permissible shear stress is 70 N/mm^2. **(10)**



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