**BACHELOR OF TECHNOLOGY (C.B.C.S.) (2020 COURSE)**
**B.Tech.Sem - IV Robotics & Automation Engineering : WINTER- 2022**
**SUBJECT : DESIGN & ANALYSIS OF MACHINE COMPONENTS**

Day : Thursday
Date : 24-11-2022
**W-24786-2022**
Time : 02:30 PM-06:30 PM
Max. Marks : 60

**N. B. :**

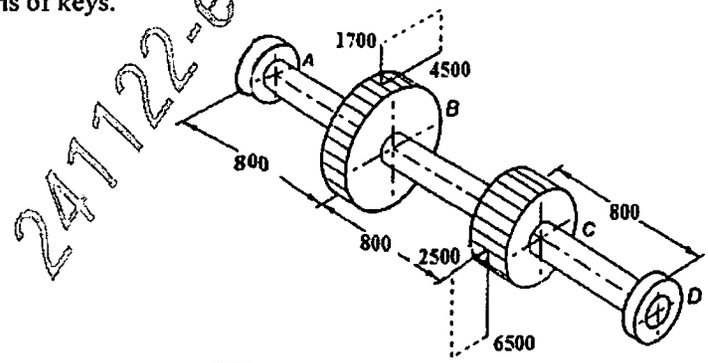
1) All questions are **COMPULSORY.**
2) Figures to the right indicate **FULL** marks.
3) Draw neat and labelled diagrams **WHEREVER** necessary.
4) Assume suitable data, if necessary.

**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 knuckle joint to connect two circular rods subjected to an axial tensile force of 35 kN. The rods are co-axial and a small amount of angular movement between their axes is permissible. Design the joint and specify the dimensions of its components. Take material for cotter as $40C8$ ($s_{yt} = 470\,N/mm^2$) and factor of safety 6. **(10)**

**Q. 2** The layout of an intermediate shaft of a gear box supporting two spur gears B and C is shown in fig. The shaft is mounted on two bearings A and D. The pitch circle diameters of gears B and C 900 and 600 mm respectively. **(10)**
The material of shaft is steel
$FeE\ 580 (Sut = 700\,N/mm^2$ and $Syt = 580\,N/mm^2)$.
The factor kb and kt of ASME code are 1.5 and 2.0 respectively. Determine the shaft diameter using the ASME code. Assume that the gears are connected to the shaft by means of keys.




**OR**

It is required to design a rigid type of flange coupling to connect two shafts. The input shaft transmits 42 kW power at 210 rpm to the output shaft through the coupling. The service factor for the application is 1.5 i.e, the design torque is 1.4 times of the rated torque. Design the coupling and specify the dimensions of its components. Shafts are made of **(10)**
$40\ C\ 8 (Syt = 380\,N/mm^2)$ and factor of safety 2.5. Keys and bolts
$30\ C\ 8 (Syt = 400\,N/mm^2)$ and FOS 2.5. It is assumed that the compressive yield strength is 150 % of the tensile yield strength.
Flanges $FG\ 200\ (Sut = 200\,N/mm^2)$ and FOS 6. It is assumed that ultimate shear strength is one half of the ultimate tensile strength.

| Shaft diameter | No. of Bolts | Shaft diameter | Key dimension | Shaft diameter | Key dimension |
|---|---|---|---|---|---|
| d < 40 | 2 | 17-22 | 6×6 | 38-44 | 12×8 |
| 40 <d<100 | 4 | 22-30 | 8×7 | 44-50 | 14×9 |
| | | 30-38 | 10×8 | 50-58 | 16×10 |

**P. T. O.**

Q. 3 The lead screw of a lathe has single start ISO metric trapezoidal threads of 40 mm nominal diameter and 9 mm pitch. The screw is required to exert an axial force of 1.5 kN in order to drive the tool carriage during turning operation. The thrust is carried on a collar of 120 mm outer diameter and 70 mm inner diameter. The values of coefficient of friction at the screw threads and the collar are 0.15 and 0.12 respectively. The lead screw rotates at 25 rpm. Calculate : **(10)**

i) The power required to drive the lead screw

ii) The efficiency of screw

**OR**

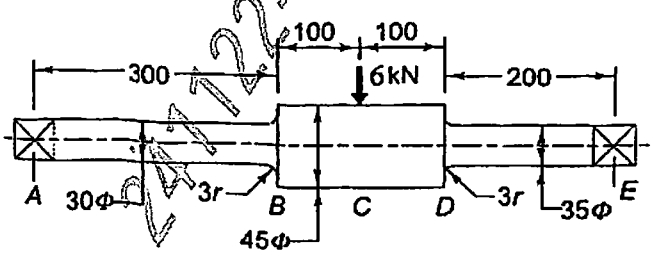
Q. 3 A semi-elliptic multi-leaf spring is used for the suspension of the rear axle of a truck. It consists of two extra full-length leaves and twelve graduated-length leaves including the master leaf. The centre to centre distance between the spring eyes is 1.2 m. The width of leaves is 60 mm. The leaves are made of steel 155 Si2Mo90($Syt = 1600\,N/mm^2$ and $E = 208000\,N/mm^2$). and the factor of safety is 3. The spring is to be designed for a maximum force of 22 kN. The leaves are pre stressed so as to equalize stresses in all leaves. Determine : **(10)**

i) The cross-section of leaves

ii) The deflection at the end of the spring

Q. 4 A rotating shaft, subjected to a non-rotating force of 6 kN and simply supported between two bearings A and E is shown in fig. The shaft is machined from plain carbon steel 30C8($Sut = 450\ N/mm^2$) and the expected reliability is 90 %. The equivalent notch radius at the Fillet section can be taken as 3 mm. What is the life of the shaft? **(10)**

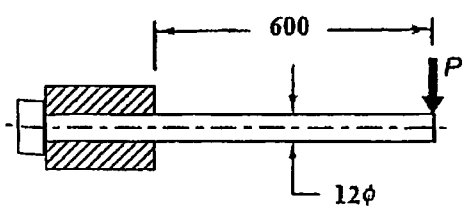
Take $Sut = 500\ N/mm^2$, $Ka = 0.77$, $Kb = 0.85$ for 90 % reliability, $Kc = 0.897$ and $Kt = 1.73$.



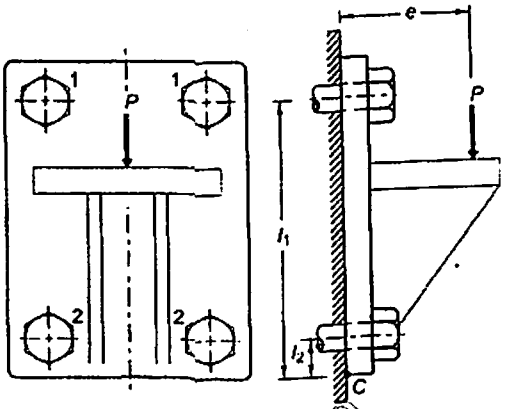

**OR**

A cantilever spring made of 10 mm diameter wire is shown in fig. The wore is made of stainless steel

4Cr18Ni10 ($Sut = 900\ N/mm^2$ *and* $Syt = 720\ N/mm^2$). The force P acting at the free end varies from 80 N to 160 N. The surface finish of the wire is equivalent to the machined surface. There is no stress concentration and the expected reliability is 50 %. Calculate the number of stress cycles likely to cause fatigue failure. Take Ka = 0.67, Kb = 0.85 For 90 % reliability Kc = 1.0.

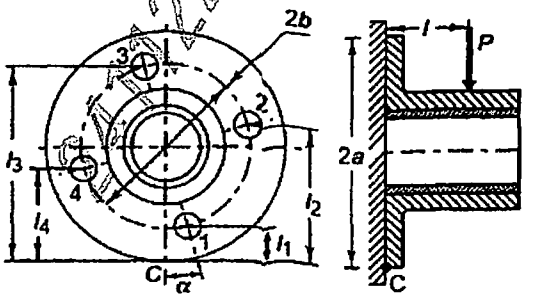


**Q. 5** The following data is given for the bracket illustrated in fig. **(10)** $P = 30\,kN$ $e = 130\,mm$ $l_1 = 200\,mm$ $l_2 = 30\,mm$. There is no pre-load in the bolts. The bolts are made of plain carbon steel $40C8 (Syt = 400\ N/mm^2)$ and the factor of safety is 3. Using the maximum shear stress theory, specify the size of the bolts.

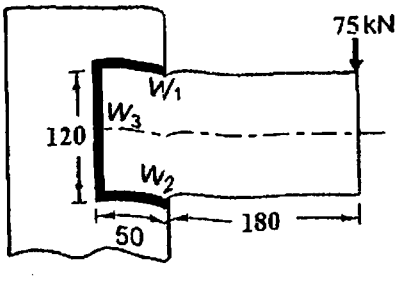



**OR**

A round flange bearing, as shown in fig, is fastened to the machine frame by **(10)** means of four cap screws spaced equally on a 280 mm pitch circle diameter. The diameter of the flange is 350 mm. The external force P is 20kN, which is located at a distance of 150 mm from the machine frame. There are two dowel pins to take shear load. The cap screws are relieved of all shear force. Determine the size of the cap screws, if the maximum permissible tensile stress in the cap screw is limited to $45\ N/mm^2$.

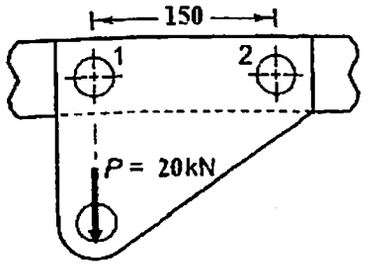



**Q. 6** A welded connection, as shown in fig. is subjected to an eccentric force of **(10)** 75 kN in the plane of the welds. Determine the size of the welds, if the permissible shear stress for the weld is $120\ N/mm^2$. Assume static conditions.



**OR**

A riveted joint, consisting of two identical rivets, is subjected to an eccentric force of 20kN as shown in fig. Determine the diameter of rivets, if the permissible shear stress in 70 $N / mm^2$. **(10)**

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