**PVP 20**

Code: 20ME3503

**III B.Tech - I Semester – Regular Examinations - DECEMBER 2022**

# DESIGN OF MACHINE ELEMENTS
## (MECHANICAL ENGINEERING)

Duration: 3 hours Max. Marks: 70

Note: 1. This paper contains questions from 5 units of Syllabus. Each unit carries 14 marks and have an internal choice of Questions.
2. All parts of Question must be answered in one place.

BL – Blooms Level CO – Course Outcome

*** Use of Approved Design data book is permitted ***

| | | | BL | CO | Max. Marks |
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| **UNIT-I** | | | | | |
| 1 | a) | Explain basic procedure of machine design. | L2 | CO1 | 7 M |
| | b) | Distinguish between design synthesis and design analysis. | L2 | CO1 | 7 M |
| **OR** | | | | | |
| 2 | a) | It is required to standardize 11 speeds from 72 to 720 rpm for a machine tool. Specify the speeds. | L2 | CO1 | 7 M |
| | b) | Define the following terms: i) Elasticity ii) Plasticity iii) Toughness of materials using stress-strain curve | L2 | CO1 | 7 M |
| **UNIT-II** | | | | | |
| 3 | a) | The stresses induced at a critical point in a machine component made of steel 45C8 ($S_{yt}$ = 380 N/mm$^2$) are as follows: $\sigma_x$ = 100 N/mm$^2$, $\sigma_y$ = 40 N/mm$^2$, $\sigma_{xy}$ = 80 N/mm$^2$. Calculate the factor of safety by (i) the maximum normal stress theory, (ii) the maximum shear stress theory. | L3 | CO1 CO2 | 7 M |
| | b) | The force acting on a bolt consists of two components—an axial pull of 12 kN and a transverse shear force of 6 kN. The bolt is made of steel FeE 310 ($S_{yt}$ = 310 N/mm$^2$) and the factor of safety is 2.5. Determine the diameter of the bolt using the maximum shear stress theory of failure. | L3 | CO1 CO2 | 7 M |

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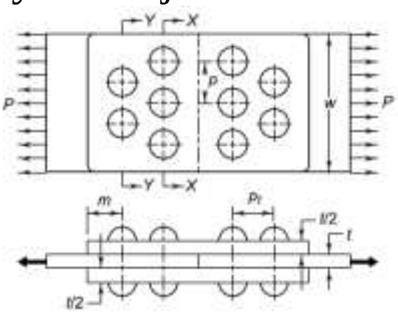
| **OR** | | | | | |
| 4 | a) | Determine the thickness of a 120 mm wide uniform plate for safe continuous operation, if the plate is to be subjected to a tensile load that has a maximum value of 250 kN and a minimum value of 100 kN. The properties of the plate material are as follows: Endurance limit stress = 225 MPa, and Yield point stress = 300 MPa. The factor of safety based on yield point may be taken as 1.5. | L3 | CO1<br>CO2 | 7 M |
| | b) | A circular bar of 500 mm length is supported freely at its two ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20 kN and a maximum value of 50 kN. Determine the diameter of bar by taking a factor of safety of 1.5, size effect of 0.85, surface finish factor of 0.9. The material properties of bar are given by, ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa. | L3 | CO1<br>CO2 | 7 M |
| **UNIT-III** | | | | | |
| 5 | Two flat plates subjected to a tensile force P are connected together by means of double-strap butt joint as shown in Figure.1. The force P is 250 kN and the width of the plate w is 200 mm. The rivets and plates are made of the same steel and the permissible stresses in tension, compression and shear are 70, 100 and 60 $N/mm^2$ respectively. Calculate: (i) the diameter of the rivets; (ii) the thickness of the plates; (iii) the dimensions of the seam, viz., p, $p_t$ and m; and (iv) the efficiency of the joint.  Figure.1 | | L4 | CO1<br>CO3 | 14 M |
| **OR** | | | | | |

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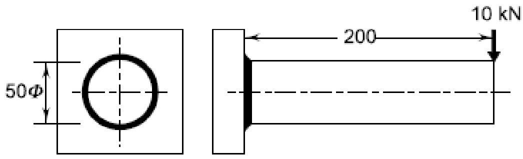
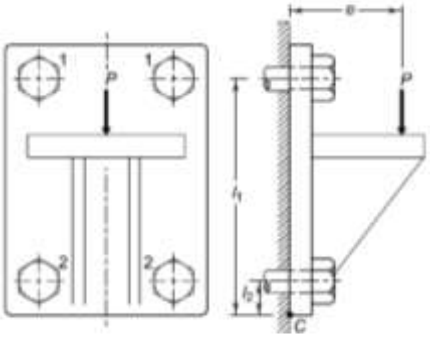
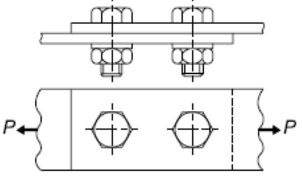
| 6 | a) | A circular beam, 50 mm in diameter, is welded to a support by means of a fillet weld as shown in Figure.2. Determine the size of the weld, if the permissible shear stress in the weld is limited to 100 $N/mm^2$.   Figure.2 | L4 | CO1 CO3 | 10 M |
| | b) | What are the advantages of welded joints compared with riveted joints? | L2 | CO1 CO3 | 4 M |
| **UNIT-IV** | | | | | |
| 7 | a) | The following data is given for the bracket illustrated in the below Figure.3. P = 25 kN, e = 100 mm, $l_1$ = 150 mm, $l_2$ = 25 mm There is no pre-load in the bolts. The bolts are made of plain carbon steel 45C8 ($S_{yt}$ = 380 $N/mm^2$) and the factor of safety is 2.5. Using the maximum shear stress theory, specify the size of the bolts.   Figure. 3 | L4 | CO1 CO3 | 7 M |
| | b) | Two plates are fastened by means of two bolts as shown in Figure.4. The bolts are made of plain carbon steel 30C8 ($S_{yt}$ = 400 $N/mm^2$) and the factor of safety is 5. Determine the size of the bolts if, P = 5 kN   Figure. 4 | L4 | CO1 CO3 | 7 M |
| **OR** | | | | | |

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| 8 | | It is required to design a cotter joint to connect two steel rods of equal diameters. Each rod is subjected to an axial tensile force of 50 kN. Design the joint and specify its main dimensions. | L4 | CO1<br>CO3 | 14 M |
| **UNIT-V** | | | | | |
| 9 | | A railway wagon moving at a velocity of 1.5 m/s is brought to rest by a bumper consisting of two helical springs arranged in parallel. The mass of the wagon is 1500 kg. The springs are compressed by 150 mm in bringing the wagon to rest. The spring index can be taken as 6. The springs are made of oil-hardened and tempered steel wire with ultimate tensile strength of 1250 $N/mm^2$ and modulus of rigidity of 81370 $N/mm^2$. The permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength. 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) pitch of the coil. | L4 | CO1<br>CO4 | 14 M |
| **OR** | | | | | |
| 10 | a) | What is nip of leaf spring? What is the objective of nipping of leaf spring? | L2 | CO1<br>CO4 | 4 M |
| | b) | A semi-elliptic spring used for automobile suspension, consists of two extra full-length leaves and eight graduated-length leaves, including the master leaf. The centre-to-centre distance between the two eyes is 1 m. The leaves are made of steel 55Si2Mo90 ($S_{yt}$ = 1500 $N/mm^2$ and E = 207000 $N/mm^2$) and the factor of safety is 2. The maximum spring load is 30 kN. The leaves are pre-stressed so as to equalize stresses in all leaves under maximum load. Determine the dimensions of the cross-section of the leaves and the deflection at the end of the spring. | L4 | CO1<br>CO4 | 10 M |