


## National Institute of Technology Hamirpur (H.P.)

B. Tech. End-Semester Examination, 2023

| Branch | $:$ | Mechanical Engineering | Course Code | $:$ ME-223 |
| :--- | :--- | :--- | :--- | :--- |
| Semester | $:$ | $4^{\text {th }}$ | Time | $: 3$ Hours |
| Course Name | $:$ | Mechanics of Solids | Max. Marks | $: 50$ |
| Session \& Time | $:$ | Morning \& (09:30-12:30 Hrs.) | Date | $: 08.05 .2023$ |

NOTE: Attempt all questions which carry marks as indicated in the []. Assume any missing data.

Q-1. (a) A vertical flag staff 9 m high is of square section 150 mm by 150 mm at the ground, tapering to 75 mm by 75 mm at the top. A horizontal pull of 1000 N is applied at the top in the direction of a diagonal of the section. Calculate the maximum stress due to bending.
(b) A round steel bar of a length of 400 mm and a diameter of 15 mm at the middle portion is subjected to an axial tensile force of 17 kN . What should be the diameter at the outer collars if the stress in the collar is not to exceed 40 MPa ? What is the magnitude of $L_{c}$, the collar length at each end, if the total extension in the bar is not to exceed $0.17 \mathrm{~mm} ? E=200 \mathrm{GPa}$


Q-2. (a) Draw SF and BM diagrams of the beam as shown on the right.

(b) A beam AB, 10 m long, carries point loads of 6 and 3 kN at C and D as shown in Fig. below. Determine support reactions, deflection at $C$ and $D$, and slope at ends A and B , if $E I$ is the flexural rigidity of the beam.


Q-3. A compound cylinder 10 cm internal diameter and 20 cm external diameter is made by shrinking one cylinder on to another. After cooling a radial stress of $20 \mathrm{~N} / \mathrm{mm}^{2}$ is produced at the common surface, which is 15 cm diameter. If the cylinder is now subjected to an internal pressure of $60 \mathrm{~N} / \mathrm{mm}^{2}$, find the maximum hoop stress and initial difference in radii ( $d r$ ). Take $E=200 \mathrm{GPa}$

Q-4. Explain von Mises theory of failure with its graphical representation. Also, explain in detail why this theory is considered the best for ductile material.
Q-5. (a) A hollow cast-iron column, with fixed ends, supports an axial load of 1 MN . If the column is 5 m long and has an external diameter of 0.25 m , find the thickness of metal required. Use the Rankine's formula, taking a constant of $1 / 6400$ and a working stress of $80 \mathrm{MN} / \mathrm{m}^{2}$.
(b) A simply supported beam of length 4 m is subjected to a uniformly distributed load of $30 \mathrm{kN} / \mathrm{m}$ over the whole span and deflects 15 mm at the centre. Determine the crippling load when the beam is used as a column for the following conditions. (i) One end is fixed, and another end is hinged (ii) Both the ends are pinned.

Q-6. A plane element in a boiler is subjected to tensile stresses of 400 MPa on one plane and 150 MPa on the other at right angle to the former. Each of the above stresses is accompanied by a shear stress of 100 MPa such that when associated with the major tensile stress tends to rotate the element in an anticlockwise direction. Find using Mohr's circle method (i) Principal stresses and their directions (ii) Maximum shearing stresses and directions of the plane on which they act.

