KATHMANDU UNIVERSITY
End Semester Examination
May/June, 2022

Marks Scored:

Level : B.E.
Year : II

Course : MEEG 202
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date :

SECTION "A"

[20Q × 1 = 20 marks]

Mark [×] in the appropriate box.

1. A metal rod is subjected to tensile stress. The metal rod is 100 mm long and the change in length due to the tensile stress is 0.05 mm. Calculate the value of the applied tensile stress. (Given E of the metal rod is 200 GPa.)
[ ] 25 MPa [ ] 50 MPa [ ] 75 MPa [ ] 100 MPa

2. A copper shaft of 1 meter is fixed on one side at 25 degrees C. If the shaft is now heated to 125 degrees C, the copper shaft will induce _____.
[ ] no stress [ ] tensile stress [ ] shear stress [ ] compressive stress

3. _____ material has identical properties in all directions.
[ ] Homogeneous [ ] Anisotropic [ ] Orthotropic [ ] Isotropic

4. A tensile load increased length of a rod by 1 mm. In a wire of the same material but of twice the length and half the cross-sectional area, the same force will produce an elongation of _____.
[ ] 1 mm [ ] 2 mm [ ] 4 mm [ ] 8 mm

5. The bending moment in the center of a simply supported beam carrying a uniformly distributed load of w per unit lent is _____.
[ ] $wl^2/8$ [ ] $wl^2/2$ [ ] $wl^2/4$ [ ] zero

6. A component made of aluminium material is to be accessed for its potential failure at certain loading condition. Which of the following failure theroy will you use?
[ ] Maximum shear stress theory [ ] Maximum strain energy theroy
[ ] Maximum principal strain theory [ ] Maximum principal stress theory

7. A simply supported beam contains uniformly varying load between the supports, the shear force diagram is represented by _____.
[ ] horizontal line [ ] inclined line [ ] parabolic curve [ ] cubic curve

8. A rectangular steel beam of width 120 mm and 20 mm height is bent into a circular path of radius 10 meters. What is the maximum bending stress in the beam? [E = 200 GPa]
[ ] 200 MPa [ ] 300 MPa [ ] 400 MPa [ ] 500 MPa

9. The neutral axis of a section is an axis at which the bending stress is _____.
[ ] zero [ ] minimum [ ] maximum [ ] infinite

10. Between two beams made of same material with the same cross-sectional area, the beam with _____ will be more effective in resisting bending.
[ ] longer length [ ] greater width
[ ] greater height [ ] symmetric cross-section

11. For a cantilever beam, slope and deflection at free end is _____.
[ ] both are zero [ ] both are minimum
[ ] both are maximum [ ] slope min and deflection max

12. In moment area method, $\theta_{B/A}$ to _____.
[ ] angle of tangent at A measured w.r.t. the tangent at B
[ ] angle of tangent at B measured w.r.t. the tangent at A
[ ] angle of tangent at A measured w.r.t. x axis
[ ] angle of tangent at B measured w.r.t. x axis

13. A UDL of 20 kN/m is applied over the entire length of the simply supported beam of length 5 m. What is the maximum deflection of the beam? [flexural rigidity = 30000 kN.m squared]
[ ] 1.08 mm [ ] 5.42 mm [ ] 6.25 mm [ ] 8.61 mm

14. Which of the following statements is/are true for a simply supported beam?
[ ] Deflection at supports in a simply supported beam is maximum
[ ] Deflection is maximum at a point where slope is zero
[ ] Slope is minimum at supports in a simply supported beam
[ ] All of the above

15. A hollow shaft of inner diameter 15 mm and outer diameter 30 mm is subjected to a torque of 100 N.m. What is the stress acting on the outer surface of the shaft?
[ ] 8.74 MPa [ ] 20.12 MPa [ ] 40.24 MPa [ ] 50.26 MPa

16. A stainless steel shaft is designed to 10 kW at the speed of 15 Hz. What is the maximum torque delivered by the shaft?
[ ] 10 N.m [ ] 50.82 N.m [ ] 106.1 N.m [ ] 152.82 N.m

17. A shart is used to transmit power from turbine to generator. If the diameter of the shaft is doubled, the power transmitting capacity will be _____.
[ ] same [ ] twice [ ] four times [ ] eight times

18. The shear stress distribution in a circular shaft subjected to a twisting moment is _____.
[ ] linear [ ] parabolic [ ] cubic [ ] could be any

19. The height of a flag pole is 3.5 meter from the ground. The effective length of the column for designing against buckling is _____.
[ ] 1.75 m [ ] 2.45 m [ ] 3.5 m [ ] 7 m

20. In which of the following cases, Euler's column formula is valid.
Case 1. Short columns
Case 2. Long columns
Case 3. Crushing stress < Buckling stress
Case 4. Crushing stress > Buckling stress
[ ] Case 1 and Case 3 [ ] Case 1 and Case 4
[ ] Case 2 and Case 3 [ ] Case 2 and Case 4

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SECTION "B"

Attempt *ALL* questions. Assume data if missing.

1. a. Explain generalized Hooke's law for 2D plane stress condition. [3]

   b. Three steel bolts of 18 mm diameter are used to attach the steel plate to a wooden beam. Knowing that the plate will support a 110 kN load and that the ultimate shearing stress for the steel used is 360 MPa, determine the factor of safety for this design. [4]

   c. The aluminum shell is fully bonded to the brass core and the assembly is unstressed at a temperature of 15 °C (Figure 1). Considering only axial deformations, determine the stress in the aluminum when the temperature reaches 195 °C. [4]

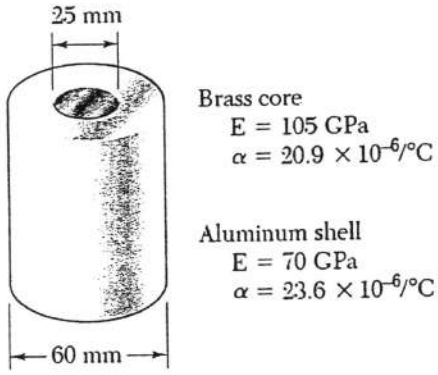

Figure 1

2. a. Define principal stresses for 2D plane stress condition . [2]

   b. Draw Mohr's circle for the 2D stress state shown in Figure 2. Based on the Mohr's circle, determine principal stress and the corresponding principal plane. [5]

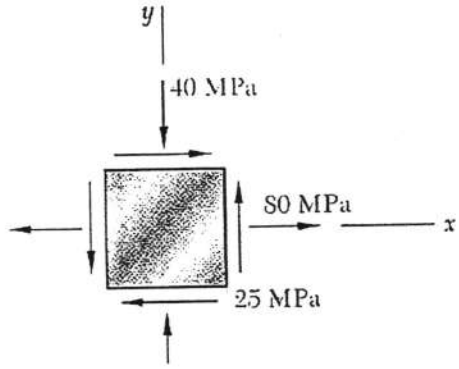

Figure 2

   c. The state of plane stress shown in Figure 2 occurs at a critical point of a steel machine component. As a result of several tensile tests, it has been found that the tensile yield strength is σy = 250 MPa for the grade of steel used. Determine the factor of safety with respect to yield, using i) the maximum shearing stress criterion, and ii) the maximum distortion energy criterion. [4]

3. a. Write down bending equation and define all the terms in the bending equation. [2]

b. For the beam and loading shown in Figure 3, the grade of timber used has an allowable normal stress of 12 MPa. [7]

i. Draw shear force diagram and bending moment diagram.

ii. Determine the required height 'h' of the beam cross section.

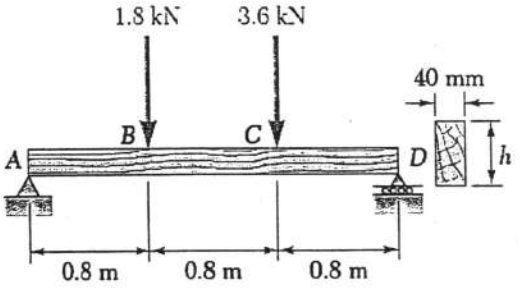

Figure 3

c. Describe the relation between deflection, slope, bending moment, shear force and rate of loading. [2]

d. A beam of length 6 m is constructed from I-section with of W310 × 38.7 as shown in Figure 4. Knowing that a = 2 m, w = 50 kN/m, E = 200 GPa, and I for W310 × 38.7 = 84.9 × 10^6 mm^4, determine [6]

i. the slope at support A

ii. the deflection at point C.

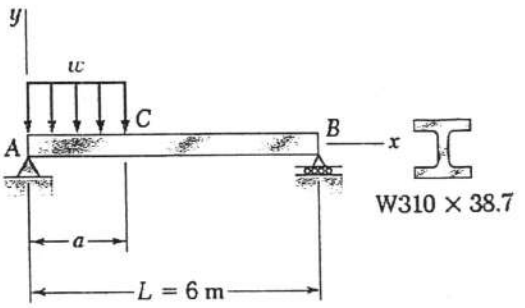

Figure 4

4. a. Calculate diameter of shaft to transmit 10 KW at a speed of 15 Hz. The maximum shear stress should not exceed 60 MPa. [3]

b. A solid circular shaft is subjected to a bending moment of 3000 N.m and a torque of 10000 N.m. The shaft is made of 45C8 steel having ultimate tensile stress of 700 MPa and a ultimate shear stress of 500 MPa. Assuming a factor of safety as 6, determine the diameter of the shaft. [3]

c. The aluminum rod AB (G = 27 GPa) is bonded to the brass rod BD (G = 39 GPa) as shown in Figure 5. Knowing that portion CD of the brass rod is hollow and has an inner diameter of 40 mm, determine the angle of twist at A. [4]

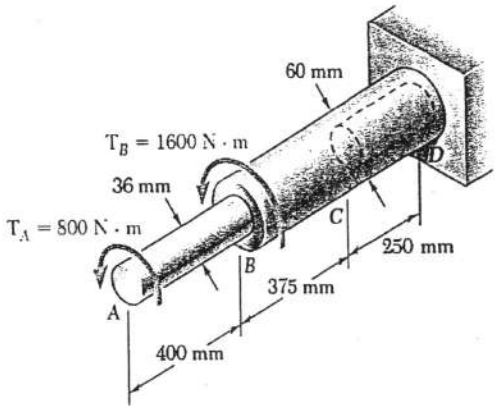

Figure 5

5. a. Define slenderness ratio of a column. [1]

b. An I – section of cross section as shown in Figure 6 and 6 m long is used as a strut with both ends fixed. What is Euler's crippling load for the strut? Take Young's modulus for the strut material as 200 GPa. [5]

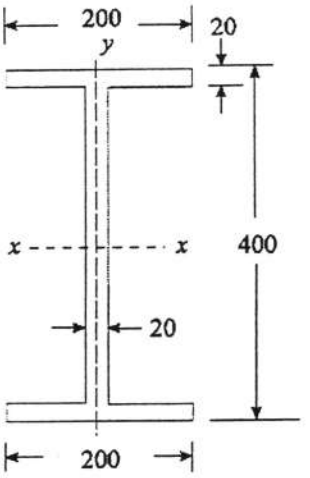

Figure 6