TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING & CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN CIVIL ENGINEERING
EMC 4222: SOLID AND STRUCTURAL MECHANICS

END OF SEMESTER EXAMINATION
SERIES: AUGUST 2024
TIME: 2 HOURS

Instructions to Candidates
You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of **five** questions.
Attempt question ONE (Compulsory) and any other TWO questions.
Do not write on the question paper.

QUESTION ONE (COMPULSORY) 30 Marks

a) Using well illustrated diagrams briefly explain the tensile test using a steel rod and detail the expected stress-strain graph with key areas of what is occurring during the test.

(8 marks)

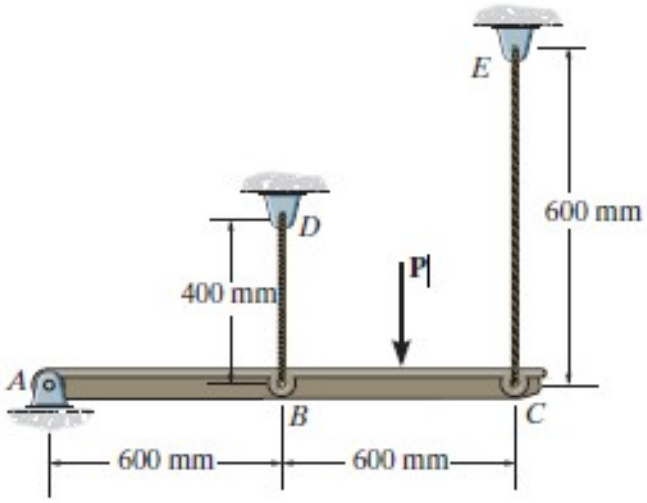
b) Define the following terms as used in structural mechanics

i. Ductile Material
ii. Brittle Material
iii. Resilience
iv. Proof Stress
v. Poisson's ratio
vi. Youngs modulus

(3 marks)

SGS ISO 9001:2008 Certified

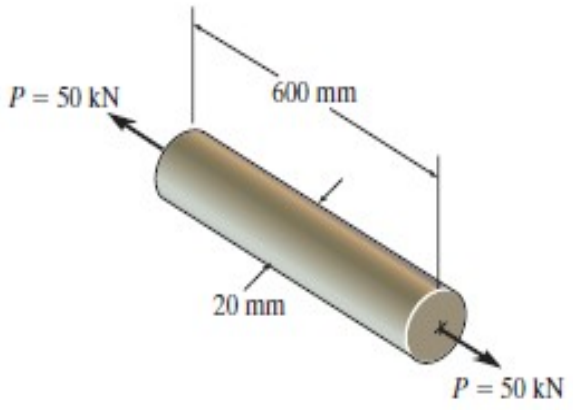
c) A force P is applied to member *ABC* which creates a clockwise rotation about pin *A* through an angle of 0.02°, determine the normal strain and stress developed in steel rod *BD* and *CE*. (E=200 GPa).



(9 Marks)

QUESTION TWO

a) A solid circular rod that is 600 mm long and 20 mm in diameter is subjected to an axial force of the elongation of the rod is δ= 1.40 mm and its diameter becomes d'=19.9837 mm Determine the modulus of elasticity and the modulus of rigidity of the material. Assume that the material does not yield.



(10 marks)

SGS ISO 9001:2008 Certified

b) A spherical gas tank has an inner radius of r = 1.5m. If it is subjected to an internal pressure of p = 300 kPa determine its required thickness if the maximum normal stress is not to exceed 12 MPa.

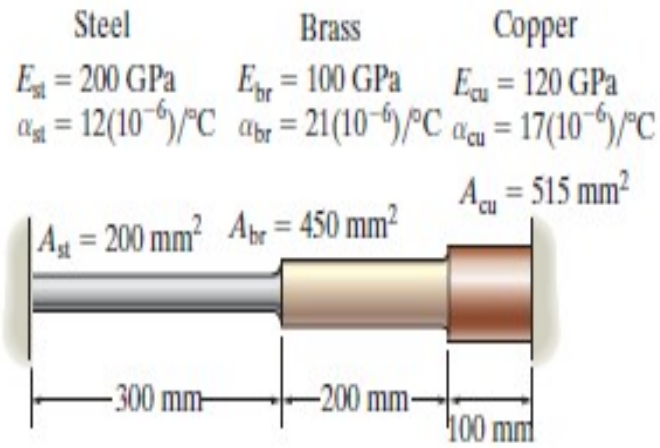
(7 marks)

c) Explain the differences of a load-extension graph vs a stress-strain graph and key reason why stress-strain is preferred.

(3 Marks)

QUESTION THREE

a) Three bars each made of different materials are connected and placed between two walls when the temperature is T_1= 20˚. Determine the force exerted on the (rigid) supports when the temperature becomes T_2= 30˚. The material properties and cross-sectional area of each bar are given in the figure.



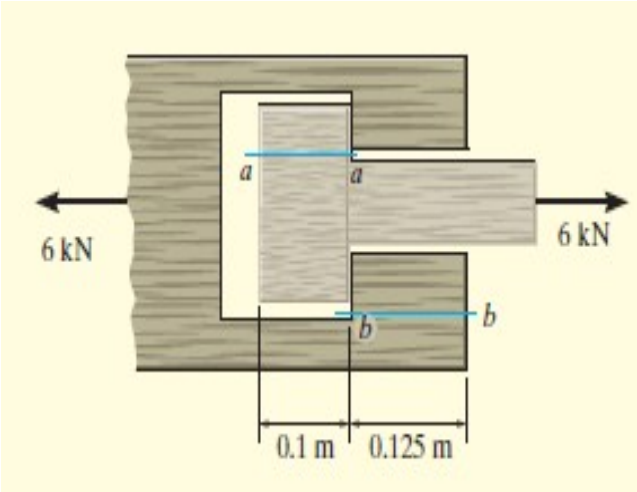
(13 marks)

b) A bar of cross section 8 mm x 8 mm is subjected to an axial pull of 7000 N. the lateral dimensions of the bar found to be changed to 7.9985 x 7.9985 mm. if the modulus of rigidity of the material is 0.8×10^5 N/mm^2, determine the Poisson's ratio and modulus of elasticity (7 marks)

QUESTION FOUR

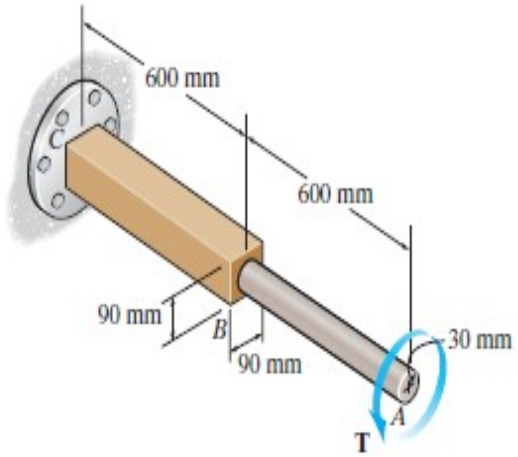
SGS ISO 9001:2008 Certified

a) If the wood joint in the figure below has a width of 150 mm, determine the average shear stress developed along shear planes *a–a* and *b–b*. For each plane, represent the state of stress on an element of the material.



(4 marks)

b) Segments *AB* and *BC* of the shaft have circular and square cross sections, respectively. The shaft is made from A-36 steel with an allowable shear stress of $\tau_{allowable}$ = 75MPA, and an angle of twist at end *A* which is not allowed to exceed 0.02 rad. Determine the maximum allowable torque **T** that can be applied at end *A*. The shaft is fixed at *C*.

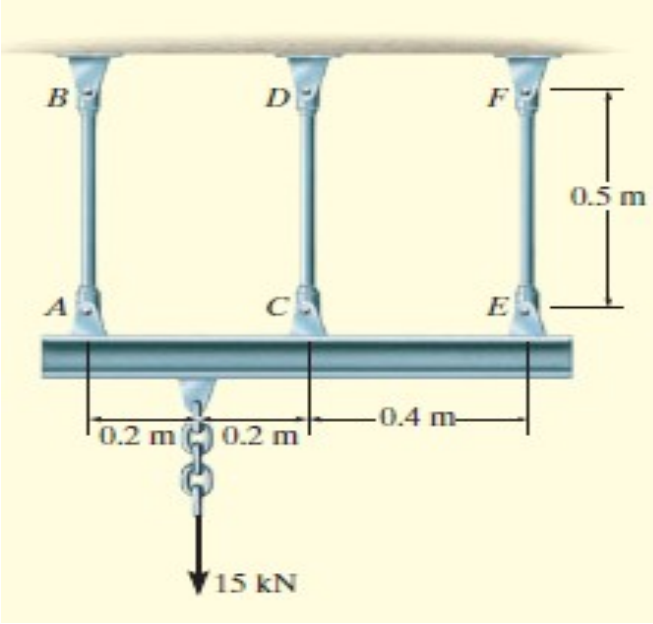


(15 marks)

SGS ISO 9001:2008 Certified

QUESTION FIVE

The three A-36 steel bars shown in the figure below *are* pin connected to a *rigid* member. If the applied load on the member is 15 kN, determine the force developed in each bar. (Bars *AB* and *EF* each have a cross-sectional area of 30 mm^2 and bar *CD* has a cross-sectional area of 10 mm^2)



(20 marks)

END OF PAPER

SGS ISO 9001:2008 Certified