TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING & CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN CIVIL ENGINEERING
EMC: STRUCTURAL MECHANICS

SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: NOVEMBER 2024
TIME: 2 HOURS

Instructions to Candidates
You should have the following for this examination

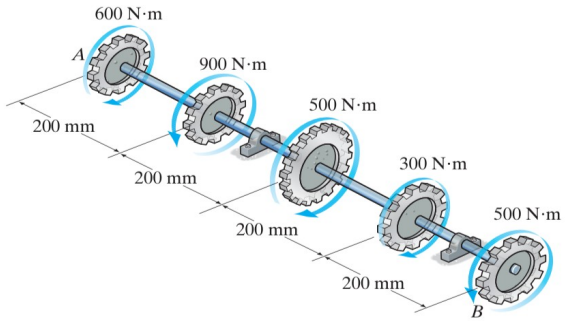
-Answer Booklet, examination pass and student ID
This paper consists of **five** questions.
Attempt question ONE (Compulsory) and any other TWO questions.
Do not write on the question paper.

QUESTION ONE (COMPULSORY) 30 Marks

a) Using well illustrated diagrams briefly explain the method of test for the compressive strength of concrete. Draw the expected stress-strain graph during the test with labels for each region.

(8 marks)

b) A series of gears are mounted on a 60-mm diameter A-36 steel shaft. Determine the angle of twist of gear B relative to gear A



(8 marks)

c) Engineering stress – strain data from a tension test of steel are illustrated in Table 1(C) below. The diameter before testing was 8.56 mm and after fracture, the minimum diameter in the necked region was 6.17 mm. determine:

i. The elastic modulus. (2 marks)
ii. 0.2% yield strength. (2 marks)
iii. Ultimate tensile strength. (2 marks)
iv. Percentage elongation after fracture. (2 marks)
v. Percentage reduction in area. (2 marks)
vi. The approximate tensile toughness. (2 marks)
vii. Strain hardening ratio. (2 marks)

Table 1(c): Stress – strain data of steel

σ MPa	ε %		σ MPa	ε %
0	0		**1217**	3.85
331	0.156		**1221**	4.77
669	0.315		**1200**	6.02
1022	0.493		**1129**	7,51
1140	0.554		**1045**	9.03
1175	0.581		**944**	10.60
1167	0.776		**829 Fracture**	12.00
1177	1.294			
1193	2.16			
1207	2.98			

QUESTION TWO

a) The ultimate strength for a hollow steel column which carries an axial load of 1900 kN is 480N/mm^2. If the external diameter of the column is 200 mm, determine the internal diameter. Take factor of safety as 4

(5 marks)

b) The bar shown in figure Q2(b) is subjected to a tensile load of 160 kN. If the stress in the middle portion is limited to 200 N/mm^2, determine the diameter of the middle portion. Find also the length of the middle portion if the total elongation of the bar is to be 0.3 mm. Young's modulus is equal to 2.1E5N/mm^2.

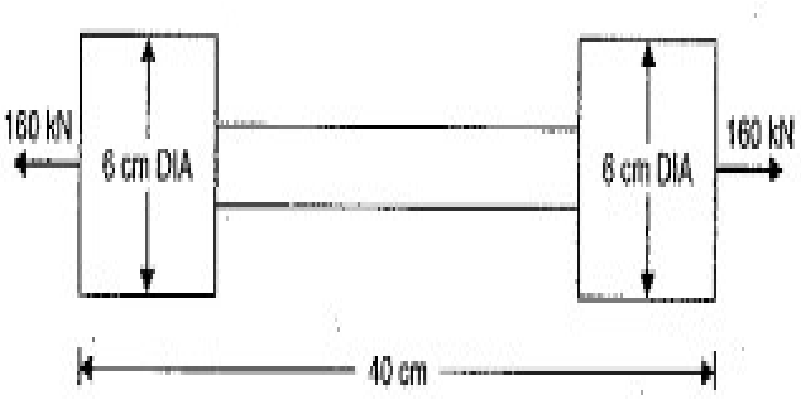


Figure Q2(b)

(7 marks)

c) Three bars made of copper, zinc and aluminum are of equal length and have a cross section of 750, 1000 and 1200mm^2 respectively. They are rigidly connected at their ends. If this compound member is subjected to a longitudinal pull of 250 kN, estimate the proportion of the load carried on each rod and the induce stresses.

(Take the value of E for copper = 1.3E5 N/mm^2, for zinc = 1.0E5 N/mm^2 and for aluminum = 0.8E5 N/mm^2.)

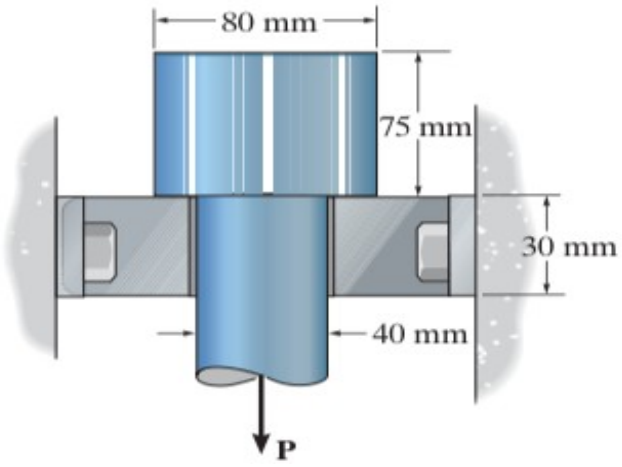
(8 marks)

QUESTION THREE

a) A bar made of A-36 steel has a thickness of 60mm, a width of 100mm and a length of 2m. If an axial force of P = 180 kN is applied to the bar, determine the change in its length and the change in the dimensions of its cross section after applying the load if the material behaves elastically.

(12 marks)

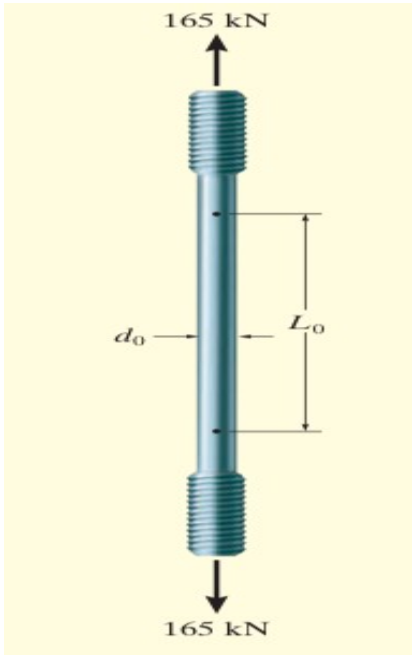
b) A bolt head and its supporting bracket are of the same material having a failure shear stress of 120MPa. Determine the maximum force, P that can be applied on the bolt so that it doesn't pull the plate. Apply a factor of safety of 2.5



(8 marks)

QUESTION FOUR

a) An aluminum specimen shown in Figure below has a diameter of d0 = 25 mm and a gauge length of L0 = 250 mm. If a force of 165 kN elongates the gauge length 1.20 mm, determine the modulus of elasticity. Also, determine by how much the force causes the diameter of the specimen to contract. Take G = 26 GPa and yield stress= 440 MPa



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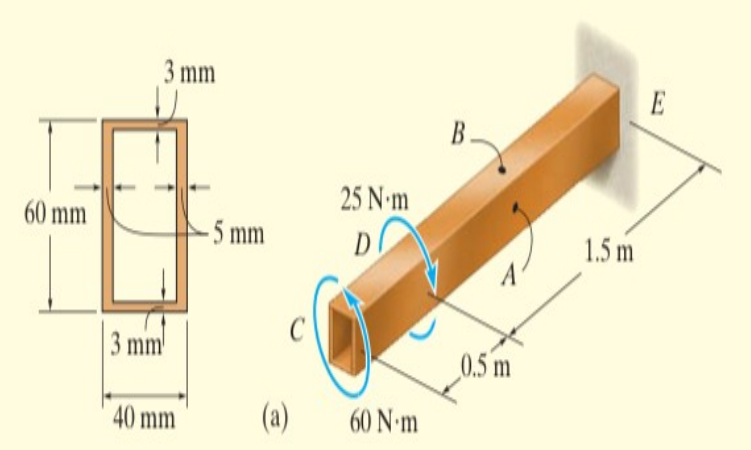
(7 marks)

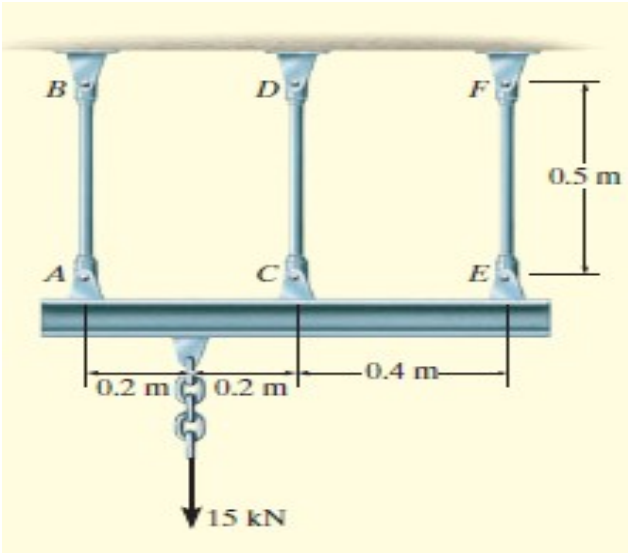
b) The tube is made of C86100 bronze and has a rectangular cross section as shown in the Figure below. If it is subjected to the two torques, determine the average shear stress in the tube at points A and B. Also, what is the angle of twist of end C? The tube is fixed at E.



(13 marks)

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)