



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: MAY 2025

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.

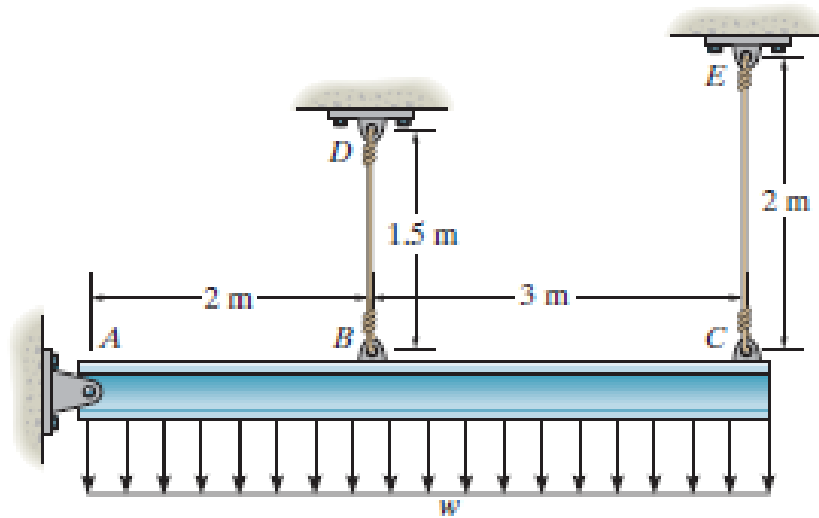
Attempt question ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

QUESTION ONE (COMPULSORY) 30 Marks

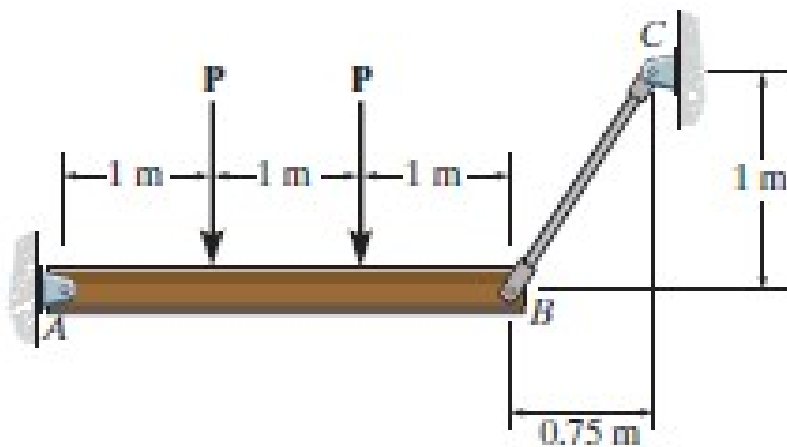
- a) Explain how we obtain the displacement equation using stress and strain.
(8 marks)
- b) What are the 2 key conditions that must be satisfied for the principle of superposition (2 marks)

- c) The rigid beam is supported by a pin at A and wires BD and CE . If the distributed load causes the end C to be displaced 10 mm downward, determine the normal strain developed in wires CE and BD .



(9 Marks)

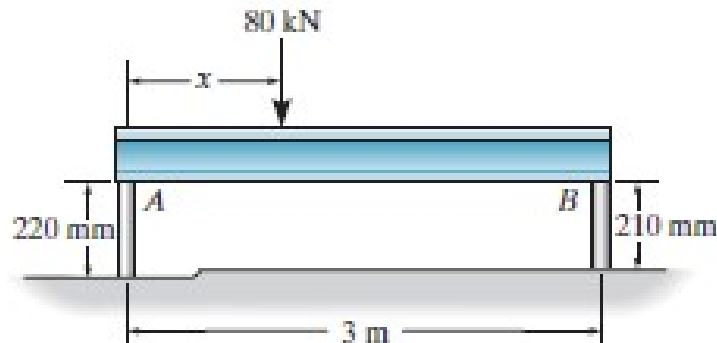
- d) When the two forces are placed on the beam, the diameter of the A-36 steel rod BC decreases from 40 mm to 39.99 mm. Determine the magnitude of each force P . $E=200\text{GPa}$.



(11 Marks)

QUESTION TWO

- a) The rigid beam rests in the horizontal position on two 2014-T6 aluminum cylinders having the unloaded lengths shown. If each cylinder has a diameter of 30 mm. determine the placement x of the applied 80-kN load so that the beam remains horizontal. What is the new diameter of cylinder A after the load is applied?
 $\nu_{Al}=0.35$ $E_{Al}=73.1\text{GPa}$ $G_{Al}=27\text{GPa}$



(15 marks)

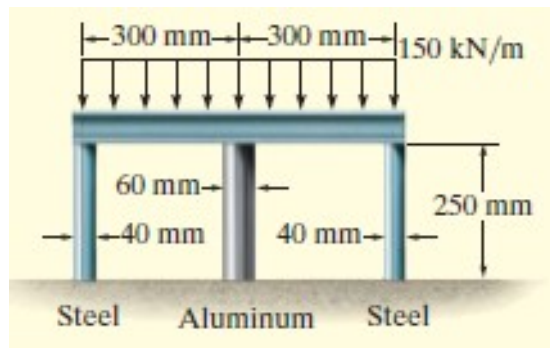
- b) A spherical gas tank has an inner radius of $r = 1.5\text{m}$. If it is subjected to an internal pressure of $p = 300\text{ kPa}$ determine its required thickness if the maximum normal stress is not to exceed 12 MPa .

(5 marks)

QUESTION THREE

- a. A Rigid beam is shown in the figure below and is fixed to 3 posts made of A-36 steel and 2014-T6 aluminium with a length of 250mm when under no load and temperature is 20 degrees Celsius. Determine the force supported by each bar when subjected to a UDL of 150 kN/m and temperature increases to 80 degrees Celsius
 Celsius

(13 marks)



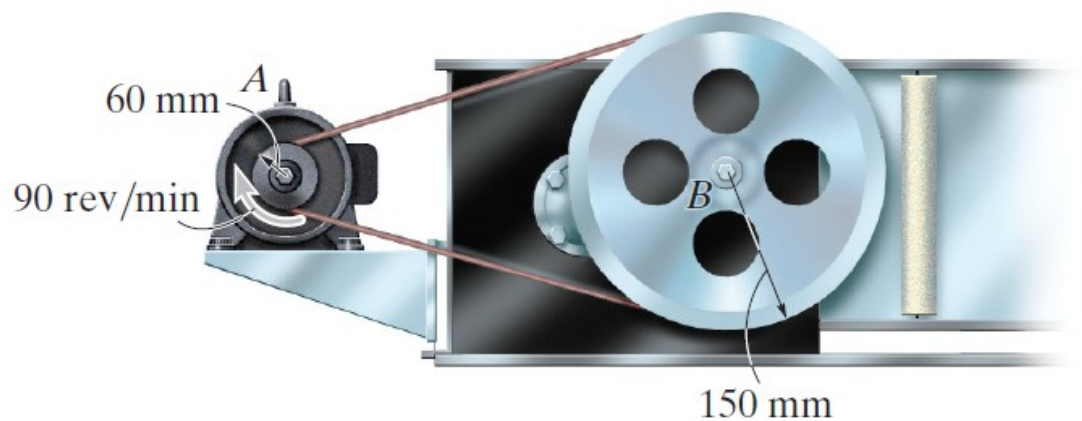
- b. A bar of cross section 8 mm x 8 mm is subjected to an axial pull of 7000 N. the lateral dimensions of the bar found to be changed to 7.9985 x 7.9985 mm. if the modulus of rigidity of the material is $0.8 \times 10^5 \text{ N/mm}^2$, determine the Poisson's ratio and modulus of elasticity (7 marks)

QUESTION FOUR

The motor A develops a power of 300 W and turns its connected pulley at 90 rev min. Determine the required diameters of the steel shafts on the pulleys at A and B if the

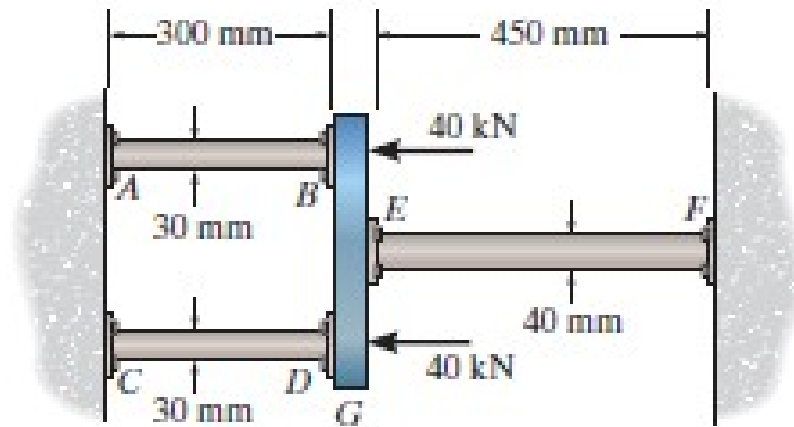
allowable shear stress is $\tau_{\text{allow}} = 85 \text{ MPa}$. Radius A is 60mm.

(20 marks)



QUESTION FIVE

The assembly consists of two red brass C83400 copper rods AB and CD having a diameter of 30 mm, a 304 stainless steel rod EF having a diameter of 40 mm, and a rigid member G. If the supports at A, C, and F each have a stiffness $k = 200 \text{ MN/m}$. Determine the average normal stress developed in the rods when the load is applied.



(20 marks)

Materials	Density ρ (Mg/m ³)	Modulus of Elasticity E (GPa)	Modulus of Rigidity G (GPa)	Yield Strength (MPa)			Ultimate Strength (MPa)			% Elongation in 50 mm specimen	Poisson's Ratio ν	Coef. of Therm. Expansion α (10 ⁻⁶)/°C	
Metallic	Aluminum Wrought Alloys 2014-T6 6061-T6	2.79	73.1	27	414	414	172	469	469	290	10	0.35	23
		2.71	68.9	26	255	255	131	290	290	186	12	0.35	24
	Cast Iron Alloys Gray ASTM 20 Malleable ASTM A-197	7.19	67.0	27	–	–	–	179	669	–	0.6	0.28	12
		7.28	172	68	–	–	–	276	572	–	5	0.28	12
	Copper Alloys Red Brass C83400 Bronze C86100	8.74	101	37	70.0	70.0	–	241	241	–	35	0.35	18
		8.83	103	38	345	345	–	655	655	–	20	0.34	17
	Magnesium Alloy [Am 1004-T61]	1.83	44.7	18	152	152	–	276	276	152	1	0.30	26
	Steel Alloys Structural A36 Stainless 304 Tool L2	7.85	200	75	250	250	–	400	400	–	30	0.32	12
		7.86	193	75	207	207	–	517	517	–	40	0.27	17
	8.16	200	75	703	703	–	800	800	–	22	0.32	12	
Titanium Alloy [Ti-6Al-4V]	4.43	120	44	924	924	–	1,000	1,000	–	16	0.36	9.4	
Nonmetallic													
Concrete	Low Strength High Strength	2.38	22.1	–	–	–	12	–	–	–	–	0.15	11
		2.38	29.0	–	–	–	38	–	–	–	–	0.15	11
Plastic Reinforced	Kevlar 49 30% Glass	1.45	131	–	–	–	–	717	483	20.3	2.8	0.34	–
		1.45	72.4	–	–	–	–	90	131	–	–	0.34	–
Wood Select Structural Grade	Douglas Fir White Spruce	0.47	13.1	–	–	–	–	2.1 ^e	26 ^d	6.2 ^d	–	0.29 ^e	–
		3.60	9.65	–	–	–	–	2.5 ^e	36 ^d	6.7 ^d	–	0.31 ^e	–