Section: ☒ Prof Habali ☐ Dr Zgoul ☐ Dr Alkhaldi (tick where appropriate) URN: [redacted]

General Instructions:

- This is a closed book, closed notes exam.
- Mobile phones are NOT allowed inside the exam Hall.
- Please attempt ALL questions.
- Use the provided space ONLY for your answers.
- Express the units properly throughout your solution.
- Present your answers in a neat and organised way.
- Exam duration: 60 mins.

Q_1 3/10
Q_2 7/10
Q_3 7/10
17/30

Warning on exam conduct

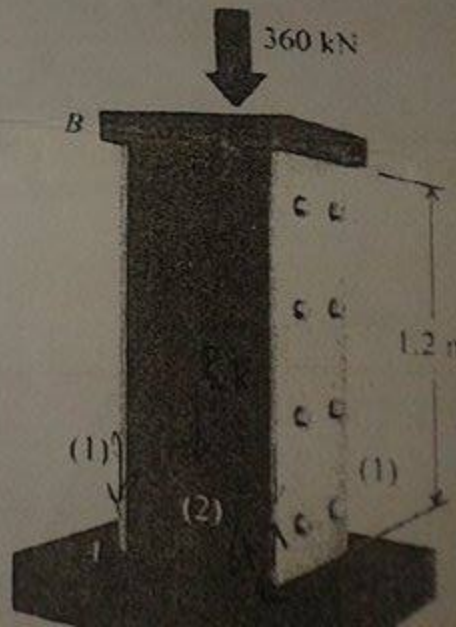
Where your conduct leads you to be reported for cheating, you will be subjected to the Academic Offences Procedure, you may receive a Warning on Exam Conduct, or reported immediately to the Assistant Dean for Student Affairs immediately where a penalty might be decided upon.

Problem I (10 Marks)

The 200 × 200 × 1,200-mm oak [E = 12 GPa] block (2) shown was reinforced by bolting two 6 × 200 × 1,200 mm steel [E = 200 GPa] plates (1) to opposite sides of the block. A concentrated load of 360 kN is applied to a rigid cap. Determine:

(a) The normal stresses in the steel plates (1) and the oak block (2).

(b) The shortening of the block when the load is applied.



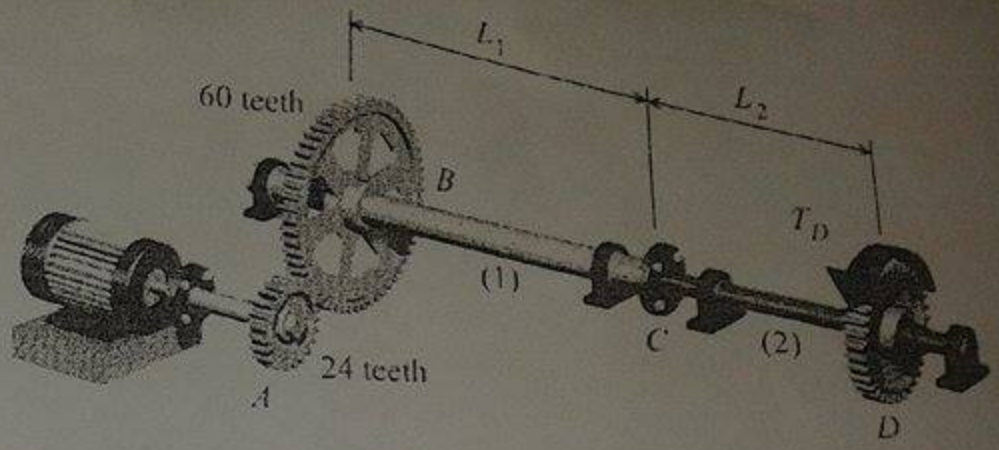
$P = 1200 / E_w = 12\,GPa / A = 200 \times 200 / 6\ bolts / E_s = 200\,GPa /$

$P = 360\,KN / (\sigma_1 = ?) / (\sigma_2 = ?) /$

(b)

Problem II (10 Marks)

A motor supplies 20 kW at 400 rpm to gear A of the drive system shown. Shaft (1) is a solid 50-mm-diameter aluminum [$G = 28$ GPa] shaft with a length of $L_1 = 1{,}200$ mm. Shaft (2) is a solid 40-mm-diameter steel [$G = 80$ GPa] shaft with a length of $L_2 = 750$ mm. Shafts (1) and (2) are connected at flange C, and the bearings shown permit free rotation of the shaft.



Determine:

(a) the maximum shear stress in shafts (1) and (2).

(b) the rotation angle of gear D with respect to gear B.

20 Kw / w = 400 rpm / d_1 = 50 / G_1 = 28 GPa / ℓ_1 = 1200 /

d_2 = 40 / G_2 = 80 GPa / ℓ_2 = 750

$\frac{nT}{}$

$T_2 = \frac{Tr}{}$ = $\frac{191083 \times 4 \times 20 \times 32}{\pi \times 40^4}$

Problem III (10 Marks)

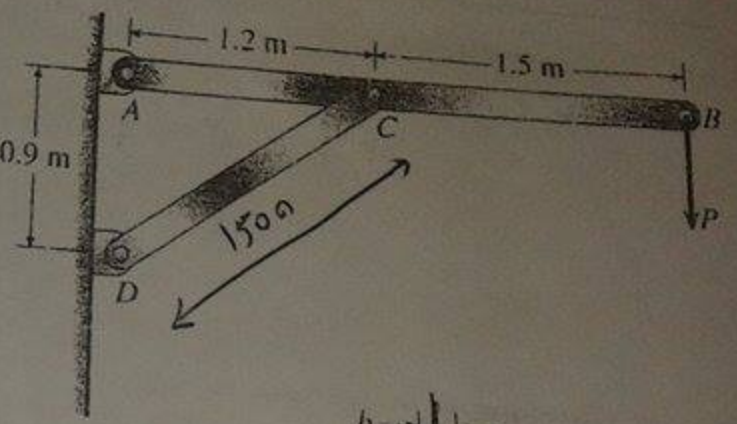
A horizontal beam AB with cross-sectional dimensions (b=19mm) x (h = 200 mm) is supported by an inclined strut CD and carries a load P = 12 kN at joint B as shown. The strut, which consists of two bars each of thickness 5b/8, is connected to the beam by a bolt passing through the three bars meeting at joint C (see the figure).

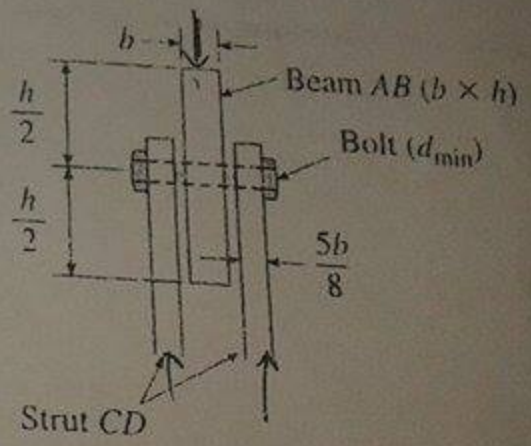
(a) If the allowable shear stress in the bolt is 90 MPa, what is the minimum required diameter d_{min} of the bolt at C?

(b) If the allowable bearing stress in the bolt is 130 MPa, what is the minimum required diameter d_{min} of the bolt at C?

(c) What is the normal stress in the strut under the effect of the load P?

(d) What is the change in length in the strut CD?





$= 11.875 / \tau_{b_{allow}} = 90$ MPa / ($d_c = ?$)