Quiz 2

ME2110: Solid Mechanics/ID 1160: Solid Mechanics-I

August-October-December, 2021

~~22nd~~ 24th September 2021

Time: ~~10:00-10:50 am~~ 12:00-12:50 pm

Maximum Marks: 15

- All questions are compulsory; use notation employed in the class; state your assumptions clearly.
- Upload a **single** pdf (no other format is allowed) with scanned/photographed solution in the Google Classroom at **12:50 pm.**
- Write your name, roll number, and signature on every page.
- If the solution(s) of a submission is(are) found to be copied, even partially, from other submission(s)/sources, the answer sheet would not be returned. The student would also be not allowed to continue the course.
- You may refer to your own class notes while attempting this quiz.

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1. Consider two circular bars, Bar A and Bar B, with a distance of δ between them as shown in the Fig. 1. The coefficient for thermal expansion of the bars A and B are α_A and α_B

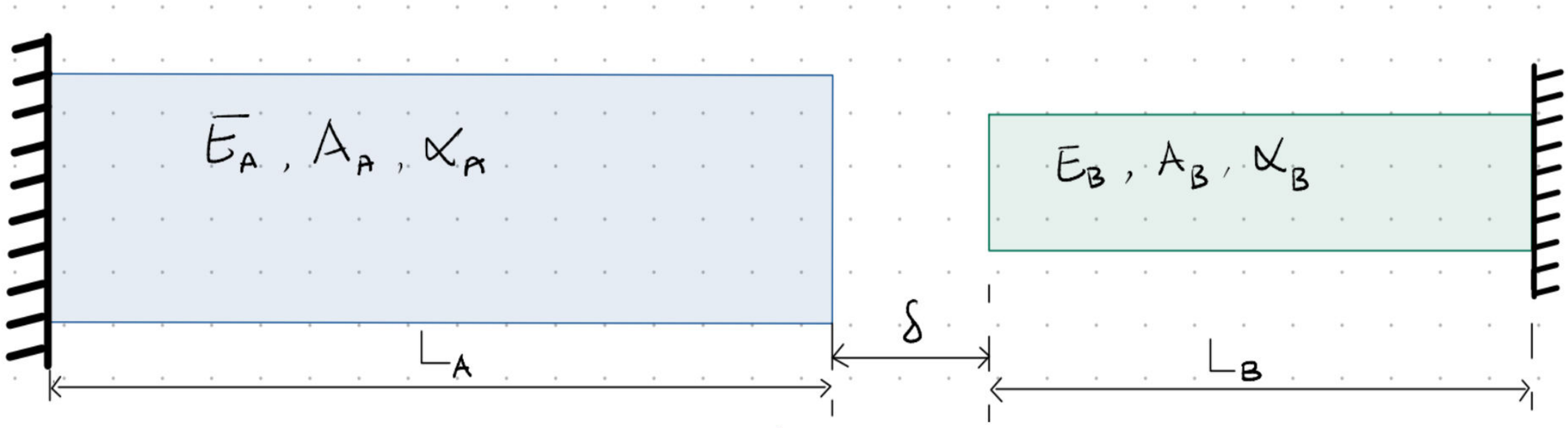

Figure 1

respectively. Their other mechanical parameters and properties are given in the figure. By assuming,

$$\Delta T > 0,$$
$$\alpha_A L_A + \alpha_B L_B \geq \frac{\delta}{\Delta T}, \tag{1.1}$$

find the normal stress developed in Bar A and change in length of Bar B for a change in temperature ΔT.

- State the importance of the assumption given by Eq. 1.1. (1 point)
- Identification of the unknowns (0.5 point)
- Equations required to solve the unknowns (1.5 points)
- Normal stress in the Bar B (1 point)
- Change in the length of the Bar B (1 point)

2. A uniform steel bar shown in Fig. 2 has a modulus of elasticity, $E = 180\,\text{GPa}$, and a coefficient of thermal expansion, $\alpha = 10\times10^{-6}\,/^{o}\,C$.

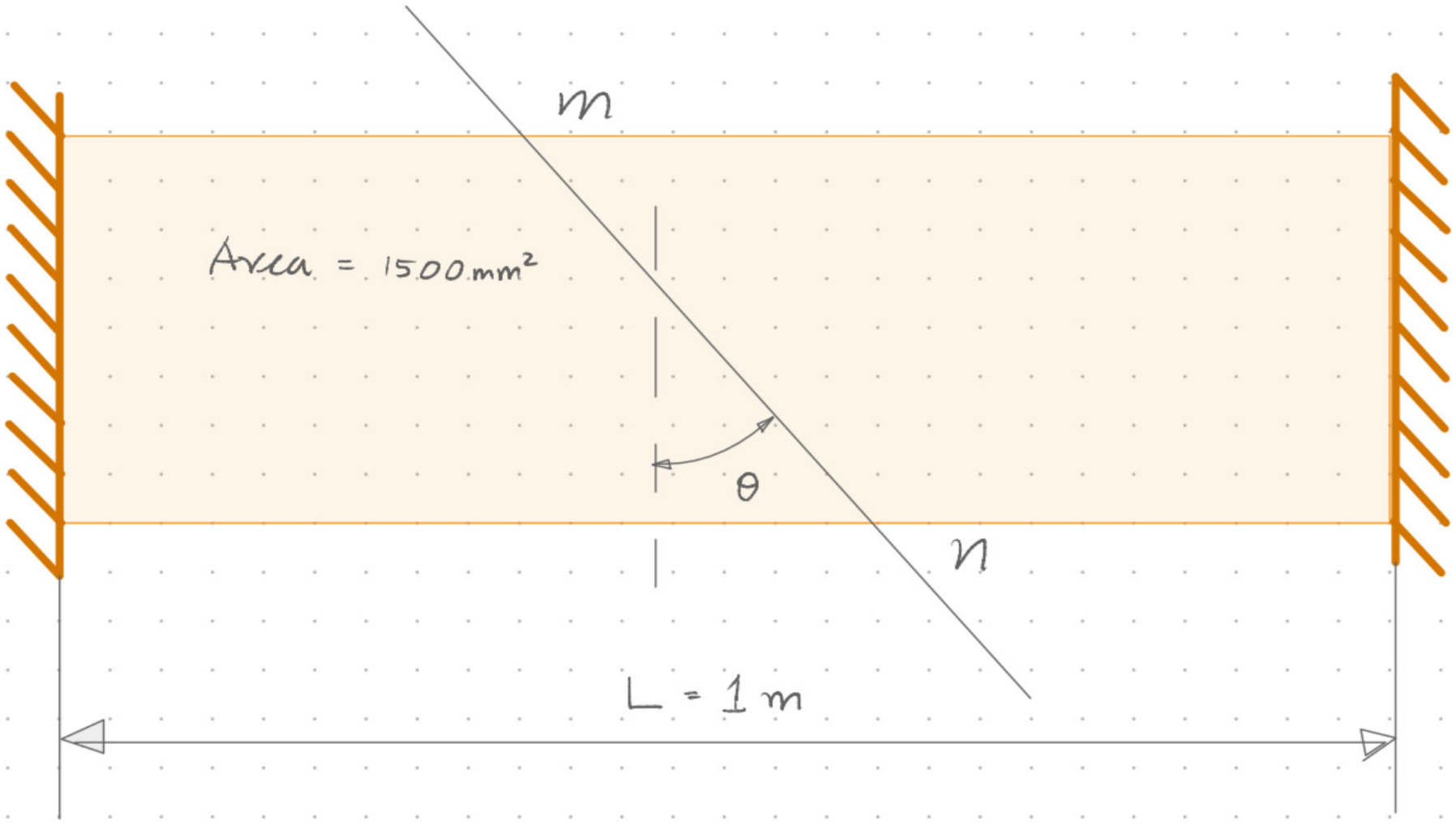

Figure 2

a) It goes through a temperature rise of $40^{o}C$. If the shear stress, τ_{θ} on the plane mn is $-20\,MPa$, find the compressive stress, σ_{θ} on the plane and the inclination, θ, of the plane.

- Relevant equations - 1 point, θ - 1 point, σ_{θ} - 0.5 point

b) If

$$\sigma_{allowable} = 70MPa, \qquad \tau_{allowable} = 32MPa, \tag{1.2}$$

find the permissible temperature change for this bar.

- Relevant calculations - 2 points, ΔT - 0.5 point

3. Do you agree with the following? Justify your answer in a sentence or two.

a) The work done by a gradually applied (quasi-static) load reaching a maximum value of P on a prismatic bar resulting in a maximum elongation δ, is $P\delta$. (1 point)

b) The relation for the maximum strain in a circular shaft, $\gamma_{max} = r\dfrac{d\phi}{dx}$, is valid for nonlinear materials too. (1 point)

c) A bar of length 1.5 times its width and area (A) is subjected to a concentrated load (P) at its end. Then the normal stress developed at a cross-section is uniform and has a magnitude of $\sigma = \dfrac{P}{A}$. (1 point)

d) A bar in a uniaxial loading cannot fail in shear. (1 point)

e) A bar can develop strain while having zero normal stress due to thermal expansion. (1 point)

- No points to be awarded without justification