# Quiz 1

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

August-October-December, 2021

2nd September 2021

Time: 09:00-09:50 AM

Maximum Marks: 15

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- 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 **09:50 AM**. Late submissions will not be considered for evaluation.
- Write your name, roll number, and signature on every page. The page not carrying your name and roll number will not be graded.
- If the solution(s) of a submission is(are) found to be copied, even partially, from other submission(s), the corresponding solution(s) of all such submissions will be awarded zero marks.
- You may refer to your own class notes while attempting this quiz.

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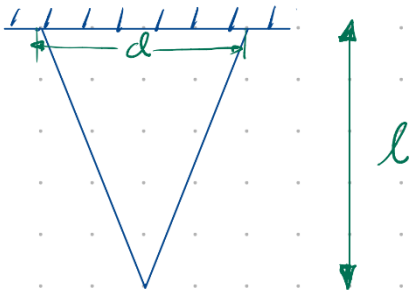
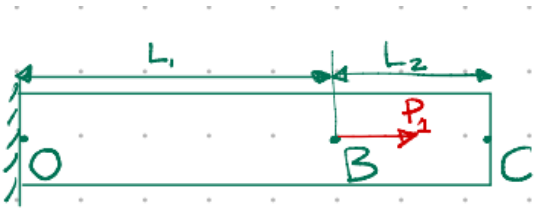
1. Consider a conical bar that is under the action of its own weight. If the length of the bar is $l$, diameter of the base is $d$, weight per unit volume of the material is $\rho g$, and Modulus of elasticity of the homogenous linearly elastic material is $E$, determine its elongation.




(***Hint:*** *Volume of a cone is one third of the volume of a cylinder with the same base area and height.*)

- Assumptions other than the ones stated in the question (1point)
- FBD of the element (1 point)
- Elongation of the element (2 points)
- Total elongation of the bar (1 point)

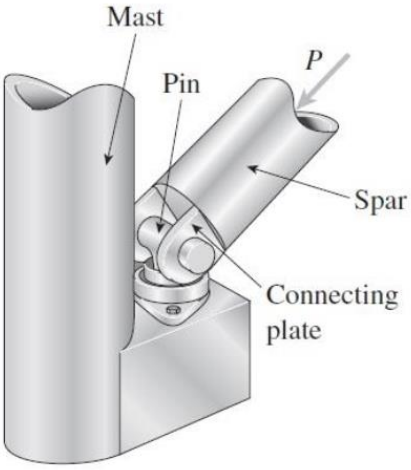
2. A prismatic bar OC has a cross-sectional area of $A$ and the modulus of Elasticity, $E$. It is loaded by a force $P_1$ at point B, which is at a distance of $L_1$ from O.




   a) Calculate the elongation of the bar. (FBD 1 point, elongation 1 point)

   b) Derive an expression for an additional load $P_2$ that should be applied at point C so that this bar does not change its length. (FBD 1 point, $P_2$ 1 point)

3. A steel tube (spar in the figure) that has an outer diameter $d_2 = 40\,\text{mm}$ and inner diameter $d_1 = 35\,\text{mm}$ is attached by a pin connection. The steel pin diameter $d = 12\,\text{mm}$, and the plates connecting the tube to the pin have thickness $t = 6\,\text{mm}$. Determine the allowable compressive force, $P$.




The allowable stresses are as follows:

- compressive stress in the tube: 70 MPa
- shear stress in the pin: 45 MPa
- bearing stress between the pin and the connecting plates: 110 MPa.

- FBD is not required for this problem
- Allowable load based on compression in the tube (1 point)
- Allowable load based on shear in the pin (2 points)
- Allowable load based on bearing (2 points)
- Allowable compressive force $P$ based on the above three considerations (1 point)