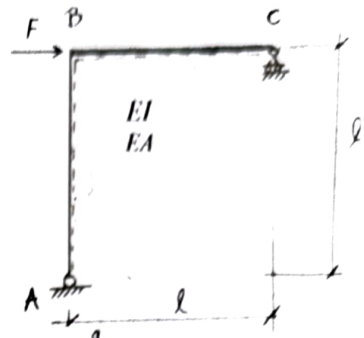
CIV-E1020 - Mechanics of Beam and Frame Structures Examination 18.10.2022

Duration: 3h - Compulsory to answer only to three exercises.

1. *a*) Determine and draw the diagrams of internal forces *M* & *N* [2 p]
b) **Determine either the rotation or the horizontal translation at the hinged roller C.** (do not solve both, only rotation or displacement)
[3 points] = account for bending and axial force
[2 points] = account only for bending
Support *A* is a hinge. It allows for rotations but not translations.



Hints: 1) Solve **always for reactions first**. 2) use the unit-force method. 3) The frame is statically determined.

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2. *a*) Using the general force method, determine and draw the bending moment diagram *M* for the continuous beam. [5p]
b) Determine the support reaction at *B*. **[1p, extra]**

Supports *A* and C are hinges. The section a *B* is continuous.
(Account only for bending in Mohr's integrals)

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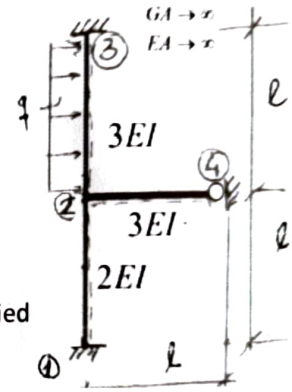
3. Determine *a*) The rotation ϕ_2 at node 2 ([4 p]), and
b) The bending moment at node 4 (fixed rigid support 4) [1 p].



Hint: slope deflection method. The support 4 is a hinge; you can use the simplified stiffness relation for the hinged beam 2-4 if you wish. Joint 2 is rigid.

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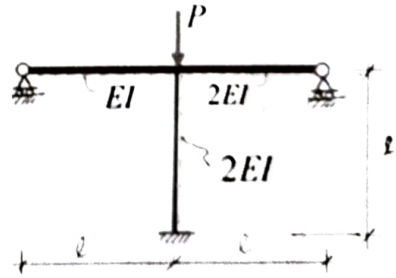
4. a) Derive, in terms of Berry's stability functions, the expression of the criticality condition for determining the critical buckling load. No need to solve numerically the buckling load. [5 p].
b) Using Euler's basic buckling cases, give a bracket for the true buckling load. [extra 1 p].



5. The frame and loading are the same as in question 4).
Assume now in this exercise 5) that the frame is non-sway.
Then derive, in terms of Berry's stability functions, the expression of the criticality condition for determining the critical buckling load. No need to solve numerically the buckling load. **[3 p]**.
(three points for this question #5 because it is a simplified version of question #4 with sway)

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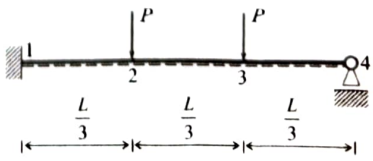
6. Determine the plastic limit load and the corresponding failure mechanism using the kinematical method and check that the yield condition is fulfilled. [5 p].



$M_p = \text{constant}$

7. Formulate the virtual work principle? **[1/2 point, extra]**

8. What is the difference, if any, between strength of material & structural mechanics **[1/2 point, extra]**