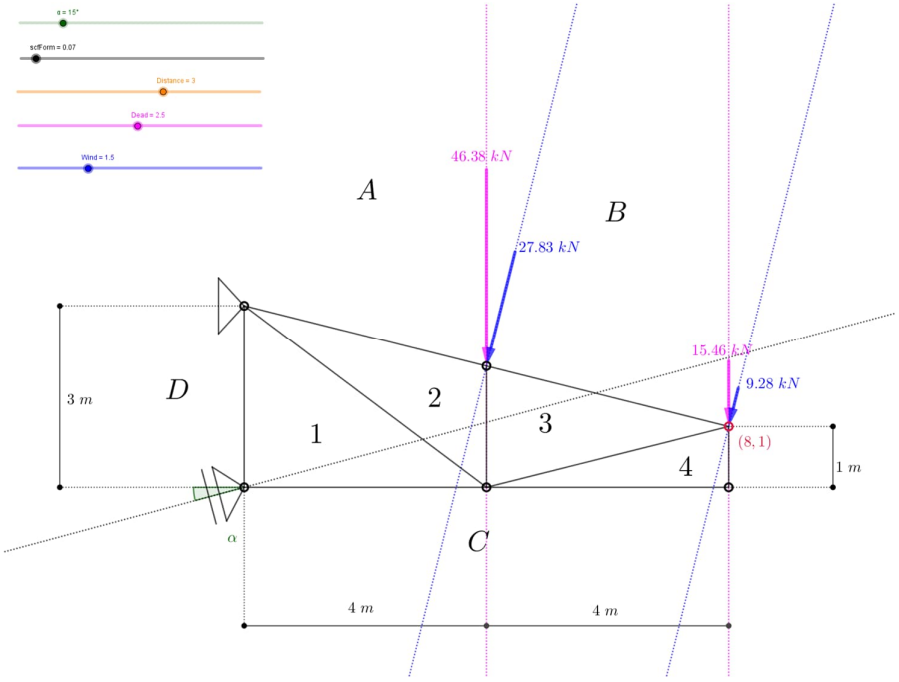
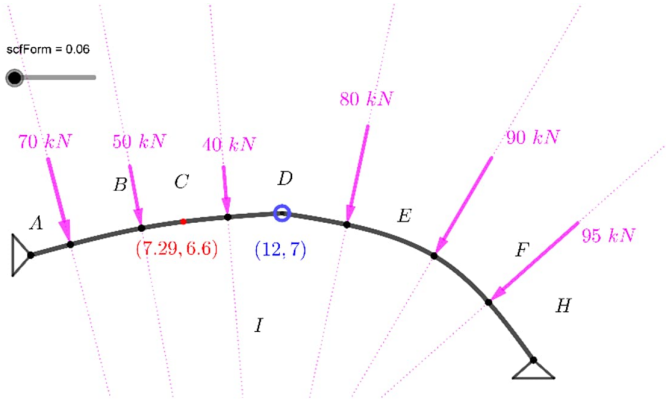
Fundamentals of Structural Design, Exam, 9th Dec 2022

i) Download and Install GeoGebra Classic 5 (https://www.geogebra.org/download)
ii) In mycourses Assignments>Exam you can download the GeoGebra files for the exam and you will need to return them in the same page.
iii) In addition, you need to return the exam questions and the handwritten answers.

1. (40%) A series of trusses is given in GeoGebra (Truss.ggb) at distance of 3 m with a dead load of 2.5kN/m^2 and a wind load of 1.5kN/m^2 and the angle of roller support with the horizontal is equal to 15 deg (the loads are scaled with scaling factor scfForm).
   a) Find the reactions, the internal forces (denote blue for tension and red for compression) by drawing the force and the funicular polygon.
   b) Which are the members that are affected by the change of the angle of the roller support α?
   c) Assuming that the material used, has modulus of elasticity E=210GPa, design a circular cross-section (find r) of the member with the largest compressive force so that the buckling load will be 20% higher than the load that the member carries. *[Circular cross section $I = \pi r^4/4$, buckling load $P_{cr} = \pi^2 EI/(KL)^2$, K=1 for hinged-hinged, 2 for cantilever, 0.7 for clamped-hinged and 0.5 for clamped-clamped].*
   d) How would the change of the orientation (connecting the other two hinges in the panel) of diagonal member 34, would affect the distribution of the forces in its panel?

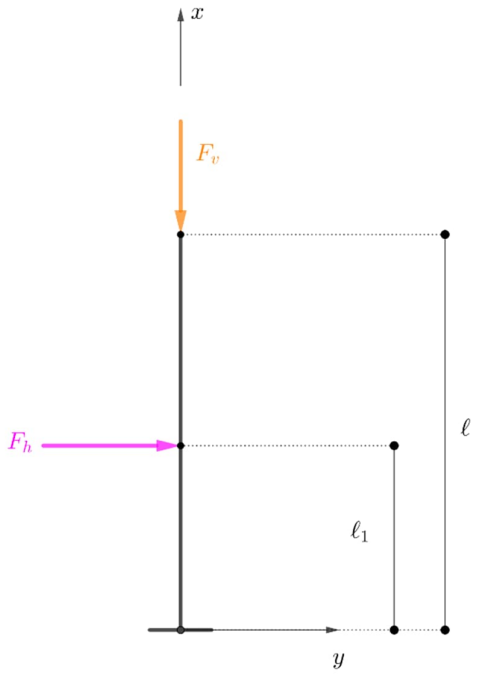


2. (40%) A three-hinged arch is given in GeoGebra (Arch.ggb) with various loads scaled with scaling factor scfForm.
   a) Find the reactions of the arch.
   b) Draw the optimal shape of the arch.
   c) What should be the new location by vertical transition of the middle hinge with coordinates (12,7) so that the arch would be unstable.
   d) What would be the shear, axial force and bending moment at the point with coordinates (7.29,6.6)



3. (20%) A cantilever beam is given as shown in the figure.
   a) Find what are the deflections due to lateral load F_h at x=l.
   b) What would be the moment of F_v at point $x=l_1$ due to deflections from F_h.

[From Euler-Bernoulli Beam theory: $M= - EI\, d^2y/dx^2$]



For all questions: for those questions that you don't have time to solve, explain how you would solve it.