**Master on Numerical Methods in Engineering**

Computational Structural Mechanics and Dynamics

# Assignment 2

## FEM Modelling - Introduction

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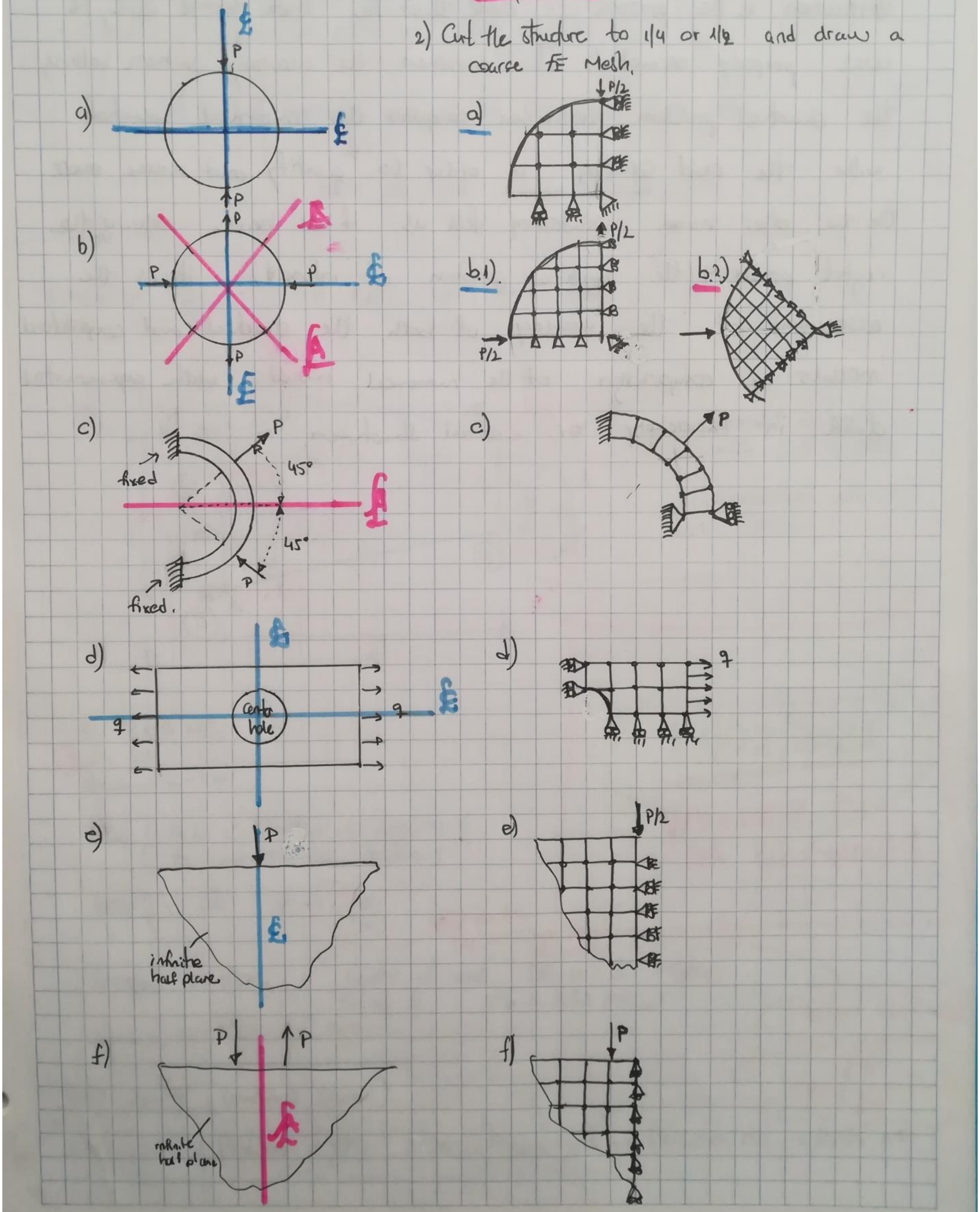
ASSIGNMENT 2.1 1) Identify simmetry & antisymmetric lines in the 2D problems.

2) Cut the structure to 1/4 or 1/2 and draw a coarse FE Mesh.



ASSIGNMENT (2.2) Verification vs Validation.

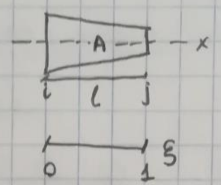
V&V are processes to measure the error on the different phases of the simulation.

Verification is the process to check that the finite element analysis was properly executed. It measures the accuracy when solving the structural problem. Verification compares the numerical solution with the exact solution in order to quantify and reduce errors.

On the other hand, validation tell us if we are solving the right problem (the physical problem of interest). It is the assessment of the accuracy of both, the structural and computational models by comparison of the numerical results with experimental data in laboratory or actual structures.

## ASSIGNMENT (2.3) On "Variational formulation"

Tapered bar element:




$A = A_i(1-\xi) + A_j\xi$

$\rho = ctc.$

It rotates on a plane at $\omega$ (rad/sec) around node $i$.

Centrifugal axial force: $q(x) = \rho A \omega^2 x \Rightarrow \rho A \omega^2 \xi l = q(\xi)$

1st) Find the consistent node forces as function of $\rho, A_i, A_j, \omega$ and $l$.

2nd) Specialize the result to the prismatic bar $A = A_i = A_j$.

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1st) Consistent nodal force vector: $f^{ext} = \int_0^1 q \begin{bmatrix} 1-\xi \\ \xi \end{bmatrix} l \cdot d\xi$ (1)

$\xi = \dfrac{x - x_1}{l}$ natural coordinate. $x_1 = 0$.

If replacing $A$ and $q(\xi)$ in (1):

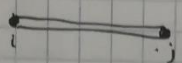
$$f^{ext} = \int_0^1 \rho A \omega^2 \xi l^2 \begin{bmatrix} 1-\xi \\ \xi \end{bmatrix} d\xi = \rho\omega^2 l^2 \cdot \int_0^1 A\xi \begin{bmatrix} 1-\xi \\ \xi \end{bmatrix} d\xi =$$

$$= \rho\omega^2 l^2 \int_0^1 \begin{bmatrix} A_i(\xi - 2\xi^2 + \xi^3) + A_j(\xi^2 - \xi^3) \\ A_i(\xi^2 - \xi^3) + A_j(\xi^3) \end{bmatrix} d\xi$$

After integration:

$$\boxed{f^{ext} = \frac{\rho\omega^2 l^2}{12} \begin{bmatrix} A_i + A_j \\ A_i + 3A_j \end{bmatrix}}$$

2nd). Prismatic bars case:




$A = A_i = A_j$

$$\boxed{f^{ext} = \rho\omega^2 l^2 \cdot \begin{bmatrix} A/6 \\ A/3 \end{bmatrix}}$$