P1

Given the differential equation $-3u'' + 30u = 8.0 \cdot \delta\left(x - \frac{1}{2}\right) + 8.0 \cdot \delta\left(x - \frac{3}{2}\right),\ 0 < x < 2$, with boundary conditions $u(0) = 3$ and $u'(2) = -3$, use the FEM approach with 2 elements, a linear one $\Omega^1 : 0 \leq x < 1$, and a quadratic one $\Omega^2 : 1 \leq x \leq 2$, to answer the following questions.

Hint: The integral of the product by a Dirac's function is $\int_a^b f(x)\delta(x-p) = f(p) \quad \textbf{if} \quad a < p < b; \quad = 0 \quad \textbf{otherways}$.

(a) (3 points) The value of F_2, the second component of the global load vector

- 4.0000e+00
- 4.2500e+00
- 4.2000e+00
- Leave it empty (no penalty) ✖
- 4.1000e+00
- 4.0500e+00

La resposta correcta és: 4.0000e+00

Hint. The value of the third component of the same vector is $F_3 = 8.0000e+00$

(b) (2 points) The value of $K_{2,2}$ is

- 2.6000e+01
- 2.9000e+01
- Leave it empty (no penalty) ✖
- 2.4000e+01
- 2.5000e+01
- 3.1000e+01

La resposta correcta és: 2.4000e+01

Hint. The value of $K_{3,2} = -6.0000e+00$.

(c) (2 points) If $u_3 = 9.5159e-02$, the value of Q_1

- 3.4653e+01
- 3.4644e+01
- 3.4221e+01
- Leave it empty (no penalty) ✖
- 3.4881e+01
- 3.3829e+01

La resposta correcta és: 3.4881e+01

(d) (3 points) Compute the interpolated value of u at $x = \frac{7}{4}$ if we know that $\psi_1^2(\frac{7}{4}) = -0.125$ and $\psi_2^2(\frac{7}{4}) = 0.75$

- -2.0854e-01
- 5.5261e-02
- -7.2473e-02
- 7.0211e-01
- 5.9153e-01
- Leave it empty (no penalty) ✖

La resposta correcta és: -2.0854e-01

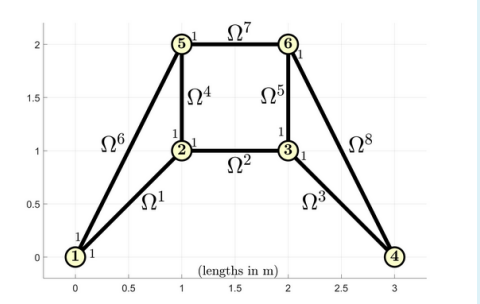
P2

Consider the bar structure showed in the figure with the numbering of elements, global and local nodes as presented there. The lengths of the bars are given in m. Supose that Young modulus in each bar is $E = 150GPa$ and its sections have area $A = 3500.00mm^2$. We consider that nodes 1 and 5 are attached while node 4 only desplacement in the x-direction is allowed. In node 6 a force of $200kN$ is loaded in the x-direction, and a force of the same magnitude but in the y-direction in the node 3. Answer the following questions (all lengths expressed in mm) :

(a) (3 points) The entry $(5, 6)$ of the stiff matrix of the global reduced system (the system of the free nodes) is

- Leave it empty (no penalty) ✖
- -8.4528e+04
- -4.6957e+04
- -3.4678e+04
- -3.1717e+04

La resposta correcta és: -4.6957e+04



Hint1: The value of the displacement in the x-direction of the node 6 is 7.619048e-01

(b) (4 points) The x component of the right extreme of the bar number 3 is now on

- $x = 2.3288e+03$
- Leave it empty (no penalty) ✖
- $x = 4.6622e+03$
- $x = 2.9876e+03$
- $x = 6.6446e+02$

La resposta correcta és: $x = 2.9876e+03$

Hint2: The y-component of the right extreme of the 7th bar now is on y=2.0087e+03

(c) (3 points) Let $l_0(i)$ the initial length of the bar i and $l_f(i)$ its final length after deformation. Then, the maximum of the absolute values of the differences between the initial and final length of each bar is

- Leave it empty (no penalty) ✖
- 1.9594e+00
- 3.7799e-01
- 1.5829e+00
- 9.4716e-01

La resposta correcta és: 1.9594e+00

Hint3: The final length of the 2 bar is $l_f(2) = 9.9966e+02$

P3

Consider the 2D domain meshed according to data in **meshPlaca4foratsTriang.m**. Assume it represents a rectangle plate with four holes drilled inside. The temperature on the plate is given by the solution of the BVP defined by the equation $-k_c \nabla T = f$, with $f = 27.67$, $k_c = 3$. The boundary conditions are: $T(x, 0) = 16.47$, $T(x, 4) = 29.08$ and $q_n = 10$ on the edge of the hole centered on (6, 1). Furthermore, a convection condition with $\beta = 7$ and $T_\infty = 25$ is imposed on the edge of the holes centered on (2, 1) and (6, 3), and a convection condition with $\beta = 6$ and $T_\infty = 24$ is imposed on the edge of the hole centered on (2, 3).
Answer the following questions:
(a) (2 points) The number of nodes in the boundary of the hole centered on (6, 1).

- (●) Leave it empty (no penalty) ✖
- ( ) 29
- ( ) 33
- ( ) 28
- ( ) 30

La resposta correcta és: 28

(b) (2 points) The value of K_{23}^{50}

- (●) Leave it empty (no penalty) ✖
- ( ) -1.4893e+00
- ( ) 2.9921e+00
- ( ) -1.2803e+00
- ( ) 2.6338e+00

La resposta correcta és: -1.2803e+00

Hint: $K_{11} = 2.6338e+00$

(c) (3 points) The mean value of the temperature in the nodes

- ( ) 2.9750e+01
- ( ) 5.8785e+01
- ( ) 2.1863e+01
- (●) Leave it empty (no penalty) ✖
- ( ) 2.2455e+00

La resposta correcta és: 2.9750e+01

Hint: The maximum value of the temperature at the nodes is 3.8340e+01

(d) (3 points) The temperature for the point p of the element 37 with barycentric coordinates (0.25, 0.25, 0.5) is

- ( ) 3.7052e+01
- ( ) 6.5595e+01
- ( ) 6.7678e+01
- ( ) 5.9001e+01
- (●) Leave it empty (no penalty) ✖

La resposta correcta és: 3.7052e+01

Hint: For the point (4,2), the interpolated temperature $T(4, 2) = 3.6732e+01$

P4

Consider the 2D domain meshed according to data in **channel1.m**. Assume it represents a domain made of an elastic material with Young Modulus $E = 4 \cdot 10^8 N/m^2$. and Poisson ratio $\nu = 0.18$. Here, the thickness is very large compared to the section area. The domain is fixed in the all left boundary and it is also fixed in the vertical direccion of the right wall. We also apply a constant traction $F_t = 1026\ N/m$ pressure (force along the boundary) on the bottom boundary in the exterior direction.

Answer the following questions:
(a) (2 points) The mean of the y-component of the nodes in the top boundary of the domain (without the two corners).

- 9.9953e-01
- 9.9461e-01
- 9.9779e-01
- Leave it empty (no penalty) ✖
- 9.9899e-01

La resposta correcta és: 9.9899e-01

Hint: The number of nodes (without the corners) in the top boundary of the domain is 99
(b) (3 points) The maximum of the absolute value of the vertical displacement of the nodes

- 1.2088e-04
- 4.7595e-04
- 1.3213e-04
- 2.7186e-04
- Leave it empty (no penalty) ✖

La resposta correcta és: 1.3213e-04

Hint: The maximum of the absolute value of the horizontal displacement of the nodes is 5.8519e-05
(c) (3 points) Node in which it reaches the maximum of the norm of the displacement.

- Leave it empty (no penalty) ✖
- 469
- 422
- 563
- 241

La resposta correcta és: 422

(d) (2 points) The Von Misses stress of the element 198

- 1.3389e+04
- 9.0482e+03
- 7.3504e+03
- Leave it empty (no penalty) ✖
- 7.0943e+03

La resposta correcta és: 7.0943e+03