Master of Seismic Engineering — E.T.S.I. Industriales (U.P.M.)
2014/15

Discretization methods for Engineering
Assignment 3: The finite element method (due 23/10/13)

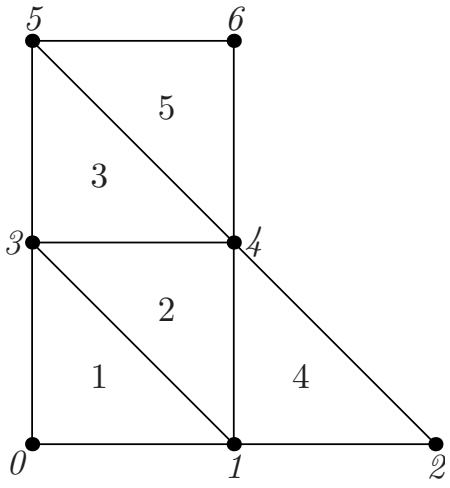
Problem 1. Calculate the integral

$$I = \int_0^{2\pi} \cos^2(x)\,\mathrm{d}x$$

with Gauss quadratures of 1,2,3, and 4 points. Compare the results with the exact value.

Problem 2. Solve a thermal problem in the solid of the figure. All the elements in the solid are identical rectangular triangles with catheti of length 1 and conductivity $k = 3$. The base of the solid has an imposed temperature of value $\theta = 5$ and the edge $5 - 6$ has also an imposed temperature of value $\theta = 10$. Finally, the point under node 4 has a fixed temperature of value $\theta = 20$. Find the solution with `matfem`, plotting the temperature profile and indicating the value of the thermal energy.

Subdivide elements 3 and 5, repeating the solution. Comment on the differences with respect to the first one.



Problem 3. Consider again the heat problem on the initial mesh of Problem 2.

i) What is the total number of degrees of freedom in the problem (free+constrained)? And the number of free dofs? Print the value of the `id` matrix and interpret the results. Look at the function `solveproblem.m` and explain how this number is calculated.

ii) Print the stiffness matrix `Kff` and the force vector `R`. What are the dimensions of these two quantities?

iii) Look at the file `el_thermal2D.m` which describes the equations that are being solved. What is the quadrature rule employed? Modify the heat source and obtain the solution for $r = \sin(y)$. Does this change the value of the internal force and the stiffness matrix? Why?