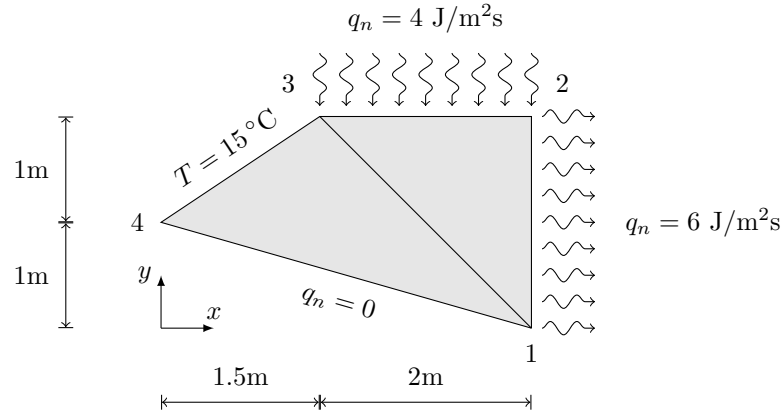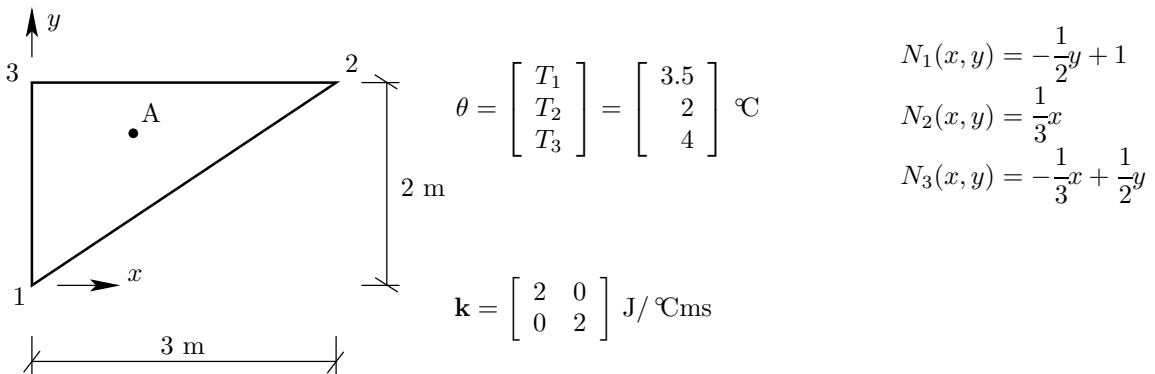**Problem 1.** For the following problem of heat flow, discretized using FEM, determine the right-hand side vector of the obtained set of algebraic equations.

$$q_n = 4 \text{ J/m}^2\text{s}$$

Problem 2. Calculate the heat flux density vector $\boldsymbol{q}$ and temperature at point $A(1.0,1.5)$ of the configuration discretized using 1 finite element. The input data contain: dof vector θ, conductivity matrix $\mathbf{k}$ and shape functions.

$$\theta = \begin{bmatrix} T_1 \\ T_2 \\ T_3 \end{bmatrix} = \begin{bmatrix} 3.5 \\ 2 \\ 4 \end{bmatrix} \text{°C}$$

$$\mathbf{k} = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \text{J/°Cms}$$

$$N_1(x,y) = -\frac{1}{2}y + 1$$

$$N_2(x,y) = \frac{1}{3}x$$

$$N_3(x,y) = -\frac{1}{3}x + \frac{1}{2}y$$

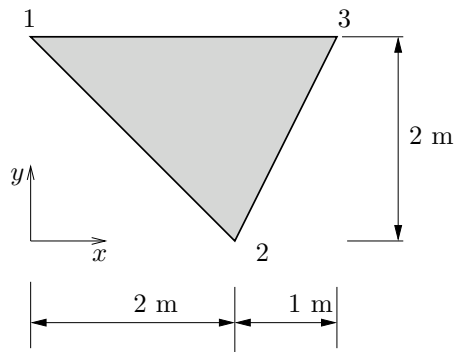**Problem 3.** The following panel is discretized with one three-noded FE. Determine the right-hand side vector used in FEM computations.

$$N_1(x,y) = -\tfrac{1}{4}y + 1$$
$$N_2(x,y) = -\tfrac{1}{3}x + \tfrac{1}{4}y$$
$$N_3(x,y) = \tfrac{1}{3}x$$
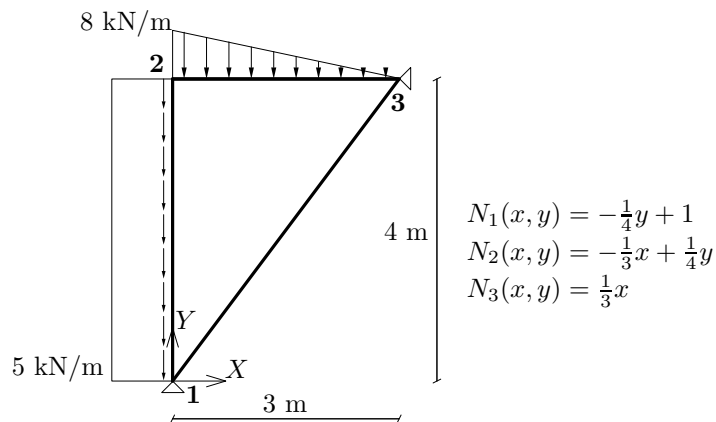
Problem 4. For the panel (plane stress problem) discretized with 4 finite elements determine the global loading vector.
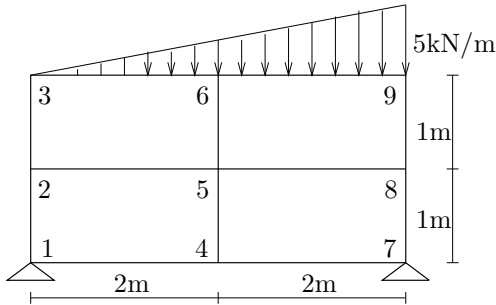
Problem 5. Derive the shape functions for the triangular finite element.

Problem 6. The following plane stress structure has been computed using FEM. For the plotted element the solution vector is given. Compute the strain and the stress vectors at point A with coordinates (1,1).

$$\mathbf{d^e} = \big\{0 \quad -12 \cdot 10^{-4} \quad 0 \quad 0 \quad 0 \quad 0 \quad 12 \cdot 10^{-4} \quad 0\big\}$$

E = 50 GPa
$\nu = 0$
h = 0.2 m

$$\mathbf{D} = \frac{E}{1 - \nu^2} \begin{bmatrix} 1 & \nu & 0 \\ \nu & 1 & 0 \\ 0 & 0 & \frac{1-\nu}{2} \end{bmatrix}$$

$N_1(x, y) = \left(-\frac{1}{3}x + 1\right)\left(-\frac{1}{4}y + 1\right)$
$N_2(x, y) = \left(\frac{1}{3}x\right)\left(-\frac{1}{4}y + 1\right)$
$N_3(x, y) = \left(\frac{1}{3}x\right)\left(\frac{1}{4}y\right)$
$N_4(x, y) = \left(-\frac{1}{3}x + 1\right)\left(\frac{1}{4}y\right)$