1 Versió 1 (la més recent)

Pregunta 1

Resposta desada

Puntuat sobre 10,00

We wish to study how the temperature varies with depth in an open air water tank. For that, we take a vertical segment from the bottom to the surface at the tank midpoint, and mesh it with 3 linear elements of equal length as shown in the image.

The water temperature follows the 1D Poisson equation $-k_c\frac{d^2T}{dx^2} = f(x)$, where k_c is the thermal conductivity of water, and the internal heat source is the warming of the tank, with a power density $f(x) = (8x + 4)W/m$ (x is the height above the tank bottom in m).

(a) (3 points)Take as thermal conductivity of water $k_c = 0.57\frac{W}{mC}$. Find the sum of all the coefficients in the stiffness matrix K.

- (●) 0
- ( ) 1.14
- ( ) 2.28
- ( ) Leave it empty (no penalty)
- ( ) 13.68

Hint: $K(2, 3) = -1.14$.

(b) (4 points) Approximate the thermal conductivity of water as $k_c = 0.5\frac{W}{mC}$. The temperature has been found to be $T_1 = 20C$ at the bottom of the tank, and $T_4 = 25.3C$ at the surface. Assume that there is no convection, and consider the power density function f on each element $[n_i, n_{i+1}]$ as **constant**, with its midpoint value $f(\frac{n_i+n_{i+1}}{2})$. Find the heat flow Q_4.

- (●) -7.0667
- ( ) Leave it empty (no penalty)
- ( ) -7.5
- ( ) 7.5
- ( ) 7.0667

Hint: $Q_1 = -7.9333$.

(c) (3 points) Keep the value $0.5\frac{W}{mC}$ for the thermal conductivity of water. Now assume the same constant approximation for f as in the previous section and that the temperature at the bottom of the tank is $T_1 = 20C$. Let's consider now that there is convection on the tank surface (that is, in node 4), following the law $k_c\frac{dT}{dx} + \beta(T - T_\infty) = 0$, with air temperature $T_\infty = 22C$ but with an unknown value for β. Deduct the value of β from the fact that the surface temperature is $T_4 = 25.3C$. Approximate f as in (b).

- ( ) 2.1613
- ( ) Leave it empty (no penalty)
- ( ) 2.1423
- (●) 2.1414
- ( ) 2.0557

Hint: solve the FEM problem with convection given by β and unknown T_4. You will get a value for T_4 which will depend on β.

Torna a començar | Desa | Emplena amb les respostes correctes | Envia i acaba | Tanca la previsualització

▸ Comentaris

Expandeix-ho tot

Opcions de previsualització

Opcions de visualització

Informació tècnica ▸

Camps personalitzats de preguntes

Download this question in Moodle XML format