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17/ENGG03/033 Civil Engineering

$$u_t - (u_{xx}) = 0$$

$$\frac{du}{dt} = c \frac{d^2 u}{dx^2} = 0$$

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$$\frac{u_{i,j+1} - u_{i,j}}{\Delta t} = c \frac{u_{i+1,j} - 2u_{i,j} + u_{i-1,j}}{\Delta x^2}$$

$$u_{i,j+1} - u_{i,j} = \frac{(\Delta t [u_{i+1,j} - 2u_{i,j} + u_{i-1,j}])}{\Delta x^2} \cdot r \cdot \frac{\Delta t}{\Delta x^2}, c=1$$

$$u[x_0] = x^4 k$$

$$\Delta x = 0.2m, \Delta t = 0.02$$

for initial conditions

$$\text{At } x=0 \longrightarrow x^4 = 0$$

$$\text{At } x=0.2 \longrightarrow 0.2^4 = 1.6 \times 10^{-3}$$

$$\text{At } x=0.4 \longrightarrow 0.4^4 = 0.0256$$

$$\text{At } x=0.6 \longrightarrow 0.6^4 = 0.1296$$

$$\text{At } x=0.8 \longrightarrow 0.8^4 = 0.4096$$

$$\text{At } x=1 \longrightarrow 1^4 = 1$$

$$\therefore u_{i,j+1} = u_{i,j} + r [u_{i+1,j} - 2u_{i,j} + u_{i-1,j}]$$

$$U_{i,j+1} = r U_{i-1,j} + (1-2r) U_{i,j} + r U_{i+1,j} \quad \leftarrow$$

When $\bar{i} = 1, \bar{j} = 0$

$$\begin{aligned} U_{1,1} &= 0.5 U_{0,0} + 0.5 U_{2,0} \\ &= 0.5(0) + 0.5(0.0256) \end{aligned}$$

$$U_{1,1} = 0.0128$$

When $\bar{i} = 2, \bar{j} = 0$

$$\begin{aligned} U_{2,1} &= 0.5(U_{1,0}) + 0.5(U_{3,0}) \\ &= 0.5(1.6 \times 10^{-3}) + 0.5(0.1296) \end{aligned}$$

$$U_{2,1} = 0.0656$$

$$\begin{aligned} \text{When } \bar{i} = 3, \bar{j} = 0 &= U_{3,1} = 0.5(U_{2,0}) + 0.5(U_{4,0}) \\ &= 0.5(0.0256) + 0.5(0.4096) \end{aligned}$$

$$U_{3,1} = 0.2176$$

$$\begin{aligned} \text{When } \bar{i} = 4, \bar{j} = 0 &= U_{4,1} = 0.5(U_{3,0}) + 0.5(U_{5,0}) \\ &= 0.5(0.0256) + 0.5(0.4096) \end{aligned}$$

$$U_{4,1} = 0.5648$$

for $\bar{j} = 1$

$$\begin{aligned} \text{When } \bar{i} = 1 &\therefore U_{1,2} = 0.5(U_{0,1}) + 0.5(U_{2,1}) \\ &= 0.5 U_{0,1} + 0.5 U_{2,1} = 0 + 0.5(0.0656) \end{aligned}$$

$$U_{1,2} = 0.0328$$

$$\begin{aligned} \text{When } \bar{i} = 2 \quad \therefore U_{2,2} &= 0.5(U_{11}) + 0.5(U_{31}) \\ &= 0.5(0.0128) + 0.5(0.2176) \\ U_{2,2} &= 0.1152 \end{aligned}$$

$$\begin{aligned} \text{When } \bar{i} = 3 \quad \therefore U_{3,2} &= 0.5(U_{21}) + 0.5(U_{41}) \\ &= 0.5(0.0656) + 0.5(0.5648) \\ U_{3,2} &= 0.3152 \end{aligned}$$

$$\begin{aligned} \text{When } \bar{i} = 4 \quad U_{4,2} &= 0.5(U_{31}) + 0.5(U_{51}) \\ &= 0.5(0.2176) + 0.5(1) \\ U_{4,2} &= 0.6088 \end{aligned}$$

$$\begin{aligned} \text{for } J=2 \\ \text{when } \bar{i}=1 \quad \therefore U_{1,3} &= 0.5(U_{01}) + 0.5(U_{22}) \\ &= 0 + 0.5(0.1152) = 0.0576 \end{aligned}$$

$$\begin{aligned} \text{When } \bar{i} = 2 \quad \therefore U_{2,3} &= 0.5(U_{12}) + 0.5(U_{32}) \\ &= 0.5(0.328) + 0.5(0.3152) = 0.174 \end{aligned}$$

$$\begin{aligned} \text{When } \bar{i} = 3 \quad \therefore U_{3,3} &= 0.5(U_{22}) + 0.5(U_{42}) \\ &= 0.5(0.1152) + 0.5(0.6088) = 0.362 \end{aligned}$$

$$\begin{aligned} \text{When } \bar{i} = 4 \quad \therefore U_{4,3} &= 0.5(U_{32}) + 0.5(U_{52}) \\ &= 0.5(0.3152) + 0.5(1) = 0.6576 \end{aligned}$$

for $J=3$

$$\begin{aligned} \text{when } \bar{i} = 1 \therefore U_{114} &= 0.5(U_{013}) + 0.5(U_{213}) \\ &= 0.5(0) + 0.5(0.174) = 0.087 \end{aligned}$$

$$\begin{aligned} \text{when } \bar{i} = 2 \therefore U_{214} &= 0.5(U_{113}) + 0.5(U_{313}) \\ &= 0.5(0.0576) + 0.5(0.362) = 0.2098 \end{aligned}$$

$$\begin{aligned} \text{when } \bar{i} = 3 \therefore U_{314} &= 0.5(U_{213}) + 0.5(U_{413}) \\ &= 0.5(0.174) + 0.5(0.6576) = 0.4158 \end{aligned}$$

$$\begin{aligned} \text{when } \bar{i} = 4 \therefore U_{414} &= 0.5(U_{313}) + 0.5(U_{513}) \\ &= 0.5(0.362) + 0.5(1) = 0.681 \end{aligned}$$

for $J=4$

$$\begin{aligned} \text{when } \bar{i} = 1 \therefore U_{115} &= 0.5(U_{014}) + 0.5(U_{214}) \\ &= 0.5(0.2098) + 0.5(0) = 0.1049 \end{aligned}$$

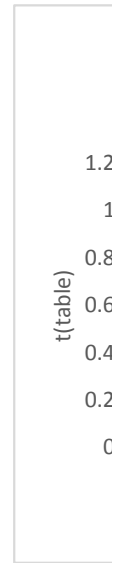
$$\begin{aligned} \text{when } \bar{i} = 2 \therefore U_{215} &= 0.5(U_{114}) + 0.5(U_{314}) \\ &= 0.5(0.087) + 0.5(0.4158) = 0.2514 \end{aligned}$$

$$\begin{aligned} \text{when } \bar{i} = 3 \therefore U_{315} &= 0.5(U_{214}) + 0.5(U_{414}) \\ &= 0.5(0.2098) + 0.5(0.681) = 0.4454 \end{aligned}$$

$$\begin{aligned} \text{when } \bar{i} = 4 \therefore U_{415} &= 0.5(U_{314}) + 0.5(U_{514}) \\ &= 0.5(0.4158) + 0.5(1) = 0.7079 \end{aligned}$$

Δt	J / Temp (K)						
0.1	5	0	0.1049	0.2514	0.4454	0.7079	1
0.08	4	0	0.087	0.2098	0.4158	0.681	1
0.06	3	0	0.0576	0.174	0.362	0.6576	1
0.04	2	0	0.0328	0.1152	0.3152	0.6008	1
0.02	1	0	0.0128	0.0656	0.2176	0.5648	1
0	0	0	0.0016	0.028	0.1296	0.4096	1
		0	0.2	0.4	0.6	0.8	1
Δx	i	0	1	2	3	4	5

0.1	0	0.1049	0.2514	0.4454	0.7079	1
0.08	0	0.087	0.2098	0.4158	0.681	1
0.06	0	0.0576	0.174	0.362	0.6576	1
0.04	0	0.0328	0.1152	0.3152	0.6088	1
0.02	0	0.0128	0.0656	0.2176	0.5648	1
0	0	0.0016	0.0256	0.1296	0.4096	1
	0	0.2	0.4	0.6	0.8	1



0.5

3D REPRESENTATION OF TEMPERATURE CHANGE

