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DEPT: MECHATRONIC

MAT NO: 17/ENG05/041

$$u_t - Cu_{xx} = 0$$

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

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

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

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

$$r = \frac{\Delta t}{\Delta x^2}; C=1$$

$$u(x, 0) = x^k$$

$$\Delta x = 0.2m, \Delta t = 0.02 \text{ day}$$

for initial condition

$$\text{At } x=0 \rightarrow x^k = 0$$

$$\text{At } x=0.2 \rightarrow 0.2^k = 1.6 \times 10^{-3}$$

$$\text{At } x=0.4 \rightarrow 0.4^k = 0.0256$$

$$\text{At } x=0.6 \rightarrow 0.6^k = 0.1296$$

$$\text{At } x=0.8 \rightarrow 0.8^k = 0.4096$$

$$\text{At } x=1 \rightarrow 2^k = 1$$

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

$$u_{i,j+1} = r u_{i-1,j} + (1-2r) u_{i,j} + r u_{i+1,j}$$

when $i=1, j=0$

$$u_{1,1} = 0.5 u_{1,0} + 0.5 u_{2,0}$$

$$u_{1,1} = 0.5(0) + 0.5(0.0256)$$

$$u_{1,1} = 0.0128$$

when $i=2, j=0$

$$u_{2,1} = 0.5(u_{1,0}) + 0.5(u_{0,1})$$

$$u_{2,1} = 0.5(1.6 \times 10^{-3}) + 0.5(0.1296)$$

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

when $i=3, j=0$.

$$u_{3,1} = 0.5(u_{2,0}) + 0.5(u_{1,1})$$

$$u_{3,1} = 0.5(0.0256) + 0.5(0.4096)$$

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

when $i=4, j=0$.

$$u_{4,1} = 0.5(u_{3,0}) + 0.5(u_{2,1})$$

$$u_{4,1} = 0.5(0.0256) + 0.5(0.2176)$$

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

when $j=1$

when $i=2$.

$$u_{2,2} = 0.5(u_{1,1}) + 0.5(u_{2,1})$$

$$= 0.5(u_{0,1} + 0.5u_{2,1}) + 0.5(0.0656)$$

$$= 0.0328$$

when $i=2$.

$$u_{2,2} = 0.5(u_{1,1}) + 0.5(u_{2,1})$$

$$= 0.5(0.0328) + 0.5(0.2176)$$

$$= 0.1152$$

when $i=3$

$$u_{3,2} = 0.5(u_{2,1}) + 0.5(u_{3,1})$$

$$= 0.5(0.0656) + 0.5(0.5648)$$

$$= 0.3152$$

when $i=4$

$$u_{4,2} = 0.5(u_{3,1}) + 0.5(u_{4,1})$$

$$= 0.5(0.2176) + 0.5(1)$$

$$= 0.6058$$

When $J=2$.

when $i=2$

$$\begin{aligned}u_{1,2} &= 0.5(u_{0,1}) + 0.5(u_{2,1}) \\ &= 0 + 0.5(0.1152) = 0.0576\end{aligned}$$

when $i=1$

$$\begin{aligned}u_{2,3} &= 0.5(u_{1,2}) + 0.5(u_{2,2}) \\ &= 0.5(0.0576) + 0.5(0.3152) \\ &= 0.124\end{aligned}$$

when $i=3$

$$\begin{aligned}u_{3,3} &= 0.5(u_{2,2}) + 0.5(u_{4,2}) \\ &= 0.5(0.1152) + 0.5(0.0048) \\ &= 0.362.\end{aligned}$$

when $i=4$

$$\begin{aligned}u_{4,3} &= 0.5(u_{3,1}) + 0.5(u_{3,2}) \\ &= 0.5(0.3152) + 0.5(1) \\ &= 0.6576.\end{aligned}$$

when $J=3$

when $i=1$

$$\begin{aligned}u_{1,4} &= 0.5(u_{0,3}) + 0.5(u_{2,3}) \\ &= 0.5(0) + 0.5(0.134) = 0.067.\end{aligned}$$

when $i=2$

$$\begin{aligned}u_{2,4} &= 0.5(u_{1,3}) + 0.5(u_{3,3}) \\ &= 0.5(0.0576) + 0.5(0.362) \\ &= 0.2098.\end{aligned}$$

when $i=3$

$$\begin{aligned}u_{3,4} &= 0.5(u_{2,1}) + 0.5(u_{4,3}) \\ &= 0.5(0.362) + 0.5(1) \\ &= 0.4681\end{aligned}$$

f. $T = \phi$.

when $i = 1$

$$\begin{aligned} \therefore u_{1,5} &= 0.5(u_{0,4}) + 0.5(u_{2,4}) \\ &= 0.5(0.362) + 0.5(1) \\ &= 0.481 \end{aligned}$$

f. $T = \phi$.

when $i = 1$

$$\begin{aligned} \therefore u_{1,5} &= 0.5(u_{0,4}) + 0.5(u_{2,4}) \\ &= 0.5(0.2098) \\ &= 0.1049 \end{aligned}$$

when $i = 2$

$$\begin{aligned} u_{2,5} &= 0.5(u_{1,4}) + 0.5(u_{3,4}) \\ &= 0.5(0.0889) + 0.5(0.9158) \\ &= 0.1049 \quad 0.251 \end{aligned}$$

when $i = 3$

$$\begin{aligned} \therefore u_{3,5} &= 0.5(u_{2,4}) + 0.5(u_{4,4}) \\ &= 0.5(0.2098) + 0.5(0.681) \\ &= 0.4459 \end{aligned}$$

when $i = 4$

$$\begin{aligned} u_{4,5} &= 0.5(u_{3,4}) + 0.5(u_{5,4}) \\ &= 0.5(0.4138) + 0.5(1) \\ &= 0.7079. \end{aligned}$$

T / Temp (K)		0					
5	0	0.1049	0.2519	0.4459	0.7079	1	
4	0	0.0870	0.2098	0.4158	0.6810	1	
3	0	0.0576	0.1790	0.3620	0.6576	1	
2	0	0.0378	0.1156	0.1652	0.6648	1	
1	0	0.0128	0.0656	0.2176	0.5048	1	
0	0	0.0011	0.0280	0.1296	0.4076	1	
	0	0.000	0.4000	0.6000	0.8000	1	
1	0	1	2	3	4	1	