

NAME: ORAFU FRANKLYN CHUKWUEMEKA

DEPARTMENT: CHEMICAL ENGINEERING

MATRIC NUMBER: 17/ENG01/025

LEVEL: 300

$$u_t - c^2 u_{xx} = 0$$
$$\frac{du}{dt} - c \frac{d^2u}{dx^2} = 0$$
$$\frac{du}{dt} = \frac{c d^2u}{dx^2}$$

$$\frac{u_{i,j+1} - u_{i,j}}{\Delta t} = \frac{c \cdot u_{i+1,j} - 2u_{i,j} + u_{i-1,j}}{\Delta x^2}$$
$$u_{i,j+1} - u_{i,j} = \frac{c \Delta t}{\Delta x^2} [u_{i+1,j} - 2u_{i,j} + u_{i-1,j}] \quad \text{Let } \Delta t / \Delta x^2 = r$$

$$u(x,0) = x^4 k$$
$$\Delta x = 0.2m, \quad \Delta t = 0.02 \text{ day}$$

for initial conditions

At  $x=0 \rightarrow x^4 = 0$   
At  $x=0.2 \rightarrow 0.2^4 = 1.6 \times 10^{-3}$   
At  $x=0.4 \rightarrow 0.4^4 = 0.0256$   
At  $x=0.6 \rightarrow 0.6^4 = 0.1296$   
At  $x=0.8 \rightarrow 0.8^4 = 0.4096$   
At  $x=1 \rightarrow 1^4 = 1$

$$\therefore u_{i,j+1} = u_{i,j} + r [u_{i+1,j} - 2u_{i,j} + u_{i-1,j}]$$
$$u_{i,j+1} = r u_{i-1,j} + (1-2r) u_{i,j} + r u_{i+1,j} \quad \leftarrow *$$

when  $i=1, j=0$ 
$$u_{1,1} = 0.5 u_{0,0} + 0.5 u_{2,0}$$
$$= 0.5(0) + 0.5(0.0256)$$
$$u_{1,1} = 0.0128$$

when  $i=2, j=0$ 
$$u_{2,1} = 0.5(u_{1,0}) + 0.5(u_{3,0})$$
$$= 0.5(1.6 \times 10^{-3}) + 0.5(0.1296)$$
$$u_{2,1} = 0.0656$$

$$\begin{aligned} \text{when } i=3, j=0 &= U_{3,1} = 0.5(U_{2,0}) + 0.5(U_{4,0}) \\ &= 0.5(0.0256) + 0.5(0.4096) \\ U_{3,1} &= 0.2176 \end{aligned}$$

$$\begin{aligned} \text{when } i=4, j=0 &= U_{4,1} = 0.5(U_{3,0}) + 0.5(U_{5,0}) \\ &= 0.5(0.0256) + 0.5(0.4096) \\ U_{4,1} &= 0.5648 \end{aligned}$$

for j=1.

$$\begin{aligned} \text{when } i=1 &\therefore U_{1,2} = 0.5(U_{0,1}) + 0.5(U_{2,1}) \\ &= 0.5U_{0,1} + 0.5U_{2,1} = 0 + 0.5(0.0656) \\ U_{1,2} &= 0.0328 \end{aligned}$$

$$\begin{aligned} \text{when } i=2 &\therefore U_{2,2} = 0.5(U_{1,1}) + 0.5(U_{3,1}) \\ &= 0.5(0.0128) + 0.5(0.2176) \\ U_{2,2} &= 0.1152 \end{aligned}$$

$$\begin{aligned} \text{when } i=3 &U_{3,2} = 0.5(U_{0,1}) + 0.5(U_{4,1}) \\ &= 0.5(0.0656) + 0.5(0.5648) \\ U_{3,2} &= 0.3152 \end{aligned}$$

$$\begin{aligned} \text{when } i=4 &U_{4,2} = 0.5(U_{2,1}) + 0.5(U_{5,1}) \\ &= 0.5(0.2176) + 0.5(1) \\ U_{4,2} &= 0.6088 \end{aligned}$$

for j=2

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

$$\begin{aligned} \text{when } i=2 &U_{2,3} = 0.5(U_{1,2}) + 0.5(U_{3,2}) \\ &= 0.5(0.0328) + 0.5(0.3152) = 0.174 \end{aligned}$$

$$\begin{aligned} \text{when } i=3 &U_{3,3} = 0.5(U_{2,2}) + 0.5(U_{4,2}) \\ &= 0.5(0.1152) + 0.5(0.6088) = 0.362 \end{aligned}$$

when  $i = 1$

$$= 0.5(0.3152) + 0.5(1)$$

$$u_{1,3} = 0.6576$$

for  $J = 3$

when  $i = 1$

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

$$= 0.5(0) + 0.5(0.174) = 0.087$$

when  $i = 2$

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

$$= 0.5(0.0576) + 0.5(0.362) = 0.2098$$

when  $i = 3$

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

$$= 0.5(0.174) + 0.5(0.6576) = 0.4158$$

when  $i = 4$

$$u_{4,4} = 0.5(u_{3,3}) + 0.5(u_{5,3})$$

$$= 0.5(0.362) + 0.5(0.6576 + 0.5(1))$$

$$= 0.681$$

for  $J = 4$

when  $i = 1$

$$u_{1,5} = 0.5(u_{0,4}) + 0.5(u_{2,4})$$

$$= 0.5(0) + 0.5(0.087) = 0.0435$$

when  $i = 2$

$$u_{2,5} = 0.5(u_{1,4}) + 0.5(u_{3,4})$$

$$= 0.5(0.087) + 0.5(0.4158) = 0.2514$$

when  $i = 3$

$$u_{3,5} = 0.5(u_{2,4}) + 0.5(u_{4,4})$$

$$= 0.5(0.2098) + 0.5(0.681)$$

$$= 0.4454$$

when  $i = 4$

$$u_{4,5} = 0.5(u_{3,4}) + 0.5(u_{5,4})$$

$$= 0.5(0.4158) + 0.5(1)$$

$$= 0.7079$$

$\Delta t$	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	0.0256	0.1296	0.4096	1
$\Delta x$		0	0.2	0.4	0.6	0.8	1
	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

