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17/ENG05/013

MECHATRONIC ENGINEERING

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

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

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

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

$$u_{i,j+1} - u_{i,j} = C\frac{\Delta t}{\Delta x^2}(u_{i+1,j} - 2u_{i,j} + u_{i-1,j}) \quad \Gamma_0 = \Delta t/\Delta x^2;\ C = 1$$

$$u[x,0] = x^4.$$

$\Delta x = 0.2m$, $\Delta t = 0.02$ 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 $x = 1 \rightarrow 1^4 = 1$

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

$$u_{i,j+1} = \Gamma u_{i-i,j} + (1-2r)u_{i,j} + r u_{i+i,j} \quad \text{——(*)}$$

when $i = 1, j = 0$

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

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

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

when $i = 2, j = 0$

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

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

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

when $i = 3, j = 0$

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

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

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

when i=4, j=0

$$u_{4,1} = 0.5(u_{3,0}) + 0.5(u_{5,0})$$

$$u_{4,1} = 0.5(0.0256) + 0.5(0.4096)$$

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

when j=1

when i=1

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

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

$$= 0.0328$$

when i=2

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

$$= 0.5(0.0128) + 0.5(0.2176)$$

$$= 0.1152$$

when i=3

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

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

$$= 0.3152$$

when i=4

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

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

$$= 0.6088$$

when j=2

when i=1

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

$$= 0 + 0.5(0.1152) = 0.0576$$

when i=2

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

$$= 0.5(0.0328) + 0.5(0.3152)$$

$$= 0.174$$

when i=3

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

$$= 0.5(0.1152) + 0.5(0.6088)$$

$$= 0.362$$

when i=4

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

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

$$= 0.6576$$

When $J = 3$

When $i = 1$

$$\therefore u_{1,4} = 0.5(u_{0,3}) + 0.5(u_{2,3})$$
$$= 0.5(0) + 0.5(0.134) = 0.084$$

When $i = 2$

$$\therefore u_{2,4} = 0.5(1,3) + 0.5(u_{1,3})$$
$$= 0.5(0.0576) + 0.5(0.362)$$
$$= 0.2098$$

When $i = 3$

$$\therefore u_{3,4} = 0.5(u_{2,3}) + 0.5(u_{4,3})$$
$$= 0.5(0.124) + 0.5(0.6576)$$
$$= 0.4158$$

When $i = 4$

$$\therefore u_{4,4} = 0.5(u_{3,3}) + 0.5(u_{5,3})$$
$$= 0.5(0.362) + 0.5(1)$$
$$= 0.4681$$

For $J = 4$

When $i = 1$

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

When $i = 2$

$$\therefore u_{2,5} = 0.5(u_{1,4}) + 0.5(u_{3,4})$$
$$= 0.5(0.087) + 0.5(0.4158)$$
$$= 0.2514$$

When $i = 3$

$$\therefore u_{3,5} = 0.5(u_{2,4}) + 0.5(u_{4,4})$$
$$= 0.5(0.2098) + 0.5(0.681)$$
$$= 0.4454$$

When $i = 4$

$$\therefore u_{4,5} = 0.5(u_{3,4}) + 0.5(u_{5,4})$$
$$= 0.5(0.4158) + 0.5(1)$$
$$= 0.7079$$

J / Temp (K)						
5	0	0.1049	0.2514	0.4454	0.7079	1
4	0	0.0876	0.2098	0.4158	0.6810	1
3	0	0.0576	0.1740	0.3620	0.6576	1
2	0	0.0328	0.1152	0.3152	0.6008	1
1	0	0.0128	0.0656	0.2176	0.5048	1
0	0	0.0016	0.0280	0.1296	0.4096	1
	0	0.0000	0.4000	0.6000	0.8000	1
L	0	1	2	3	4	5