ADAM TIZHE ZIRPA
17/ENG03/061
CIVIL ENGINEERING
ENG 382

$$U_t - CU_{xx} = 0$$

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

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

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

$$U_{i,j+1} - U_{i,j} = \frac{C\Delta t}{\Delta x^2}\left[U_{i+1,j} - 2U_{i,j} + U_{i-1,j}\right].$$

$r = \Delta t / \Delta x^2$, $C = 1$

$U[x,0] = x^4 k$.

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

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

$$U_{i,j+1} = rU_{i-1,j} + (1-2r)U_{i,j} + rU_{i+1,j} \longrightarrow *$$

when $i = 1$, $j = 0$

$$U_{1,1} = 0.5U_{0,0} + 0.5U_{2,0}.$$

$$= 0.5(0) + 0.5(0.256)$$

$u_{111} = 0.0128$

when $i = 2$, $j = 0$

$u_{211} = 0.5(u_{110}) + 0.5(u_{310})$

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

$u_{211} = 0.0656$

when $i = 3$, $j = 0$

$u_{311} = 0.5(u_{210}) + 0.5(u_{410})$

$= 0.5(0.0256) + 0.5(0.4096)$

$u_{311} = 0.2176$

when $i = 4$, $j = 0$

$u_{411} = 0.5(u_{310}) + 0.5(u_{510})$

$= 0.5(0.0256) + 0.5(0.4096)$

$u_{411} = 0.5648$

for $j = 1$

when $i = 1$

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

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

$u_{1,2} = 0.0328$

when $i = 2$

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

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

$u_{2,2} = 0.1152$

when $i = 3$

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

$0.5(0.0656) + 0.5(0.5648)$

$u_{3,2} = 0.3152$

when $i = 4$

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

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

$U_{4,2} = 0.6088$

for $J = 2$

when $i = 1$

$$U_{1,3} = 0.5(U_{0,1}) + 0.5(U_{2,2})$$
$$= 0 + 0.5(0.1152) = 0.0576$$

when $i = 2$

$$U_{2,3} = 0.5(U_{1,2}) + 0.5(U_{3,2})$$
$$= 0.5(0.0328) + 0.5(0.3152) = 0.174$$

when $i = 3$

$$U_{3,3} = 0.5(U_{2,2}) + 0.5(U_{4,2})$$
$$= 0.5(0.1152) + 0.5(0.6088) = 0.362$$

when $i = 4$

$$U_{4,4} = 0.5(_{3,2}) + 0.5(_{5,2})$$
$$= 0.5(0.3152) + 0.5(1)$$
$$U_{4,4} = 6.6576$$

For $J = 3$

when $i = 1$

$$U_{1,4} = 0.5(U_{0,3}) + 0.5(U_{2,3})$$
$$= 0.5(0) + 0.5(0.174) = 0.84$$
$$U_{1,4} = 0.84$$

when $i = 2$

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

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 $i = 4$

$$U_{4,4} = 0.5(U_{3,3}) + 0.5(U_{5,3})$$
$$= 0.5(0.362) + 0.5(1)$$
$$= 0$$

For $J = 4$

when $i = 1$

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

when $i = 2$

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

when $i = 3$

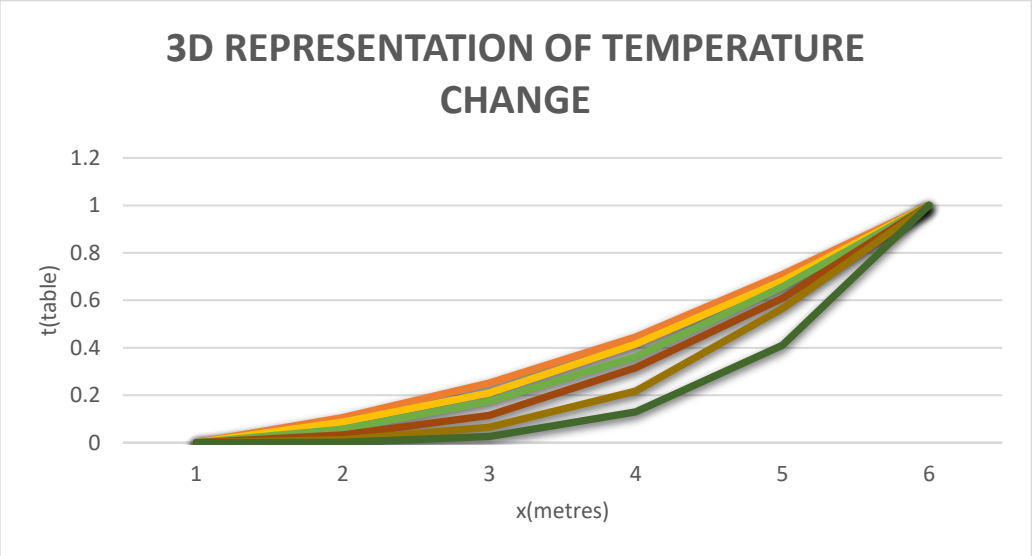
$$U_{3,5} = 0.5(U_{2,4}) + 0.5(U_{4,4})$$
$$= 0.5(0.2098) + 0.5(0.681)$$
$$U_{3,5} = 0.4454$$

when $i = 4$

$$U_{4,5} = 0.5(U_{3,4}) + 0.5(U_{5,4})$$
$$= 0.5(0.4158) + 0.5(1)$$
$$U_{4,5} = 0.7079$$

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	0.4046	1
Δx		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



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