

## Other Exps - Expansion

Mechanics Eng

$$u_t - c u_{xx} = 0$$

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

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

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

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

$r = \frac{c \Delta t}{\Delta x^2}$

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

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

for Initial Condition

$$x = 0 \rightarrow x^4 = 0$$

$$x = 0.2 \rightarrow 0.2^4 = 1.6 \times 10^{-3}$$

$$x = 0.4 \rightarrow 0.4^4 = 0.0256$$

$$x = 0.6 \rightarrow 0.6^4 = 0.1296$$

$$x = 0.8 \rightarrow 0.8^4 = 0.4096$$

$$x = 1.0 \rightarrow 1.0^4 = 1$$

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

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

when  $i=1, j=0$ 

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

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

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

when  $i=2, j=0$

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

$$u_{211} = 0.5(1.6 \times 10^{-3}) + 0.5(0.1296)$$

$$u_{211} = 0.0656$$

when  $i=3, j=0$

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

$$u_{311} = 0.5(0.0256) + 0.5(0.4096)$$

$$u_{311} = 0.2176$$

when  $i=4, j=0$

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

$$u_{411} = 0.5(0.0256) + 0.5(0.4096)$$

$$u_{411} = 0.5649$$

For  $j=1$

$$\text{when } i=1 \rightarrow u_{1;2} = 0.5(u_{011}) + 0.5(u_{211})$$

$$u_{1;2} = 0.5 u_{011} + 0.5 u_{211} = 0 + 0.5(0.0656) = 0.0328$$

$$\text{when } i=2 \rightarrow u_{2;2} = 0.5(u_{111}) + 0.5(u_{311})$$

$$u_{2;2} = 0.5(0.0328) + 0.5(0.2176) = 0.1152$$

$$\text{when } i=3 \rightarrow u_{3;2} = 0.5(u_{211}) + 0.5(u_{411})$$

$$= 0.5(0.0656) + 0.5(0.5649) = 0.3152$$

$$\text{when } i=4 \rightarrow u_{4;2} = 0.5(u_{311}) + 0.5(u_{511})$$

$$= 0.5(0.2176) + 0.5(1) = 0.6088$$

For  $j=2$

$$\text{when } i=1 \Rightarrow u_{1;3} = 0.5(u_{012}) + 0.5(u_{212})$$

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

$$\text{when } i=2 \rightarrow u_{2;3} = 0.5(u_{112}) + 0.5(u_{312})$$

$$= 0.5(0.0328) + 0.5(0.3152) = 0.174$$

$$\begin{aligned} \text{when } i=3 &\rightarrow U_{3,3} = 0.5(U_{2,2}) + 0.5(U_{4,2}) \\ U_{3,3} &= 0.5(0.1152) + 0.5(0.6098) \\ &= 0.362 \end{aligned}$$

$$\begin{aligned} \text{when } i=4 &U_{4,3} = 0.5(U_{3,2}) + 0.5(U_{5,2}) \\ &= 0.5(0.5152) + 0.5(1) \\ &= 0.6576 \end{aligned}$$

for  $j=3$

$$\begin{aligned} \text{when } i=1 &\rightarrow U_{1,3} = 0.5(U_{0,3}) + 0.5(U_{2,3}) \\ &= 0.5(0) + 0.5(0.174) \\ &= 0.084 \end{aligned}$$

$$\begin{aligned} \text{when } i=2 &\rightarrow U_{2,3} = 0.5(U_{1,3}) + 0.5(U_{3,3}) \\ &= 0.5(0.084) + 0.5(0.362) \\ &= 0.2098 \end{aligned}$$

$$\begin{aligned} \text{when } i=3 &\rightarrow U_{3,4} = 0.5(U_{2,3}) + 0.5(U_{4,3}) \\ &= 0.5(0.2098) + 0.5(0.6576) \\ &= 0.4158 \end{aligned}$$

$$\begin{aligned} \text{when } i=4 &\rightarrow U_{4,4} = 0.5(U_{3,3}) + 0.5(U_{5,3}) \\ &= 0.5(0.362) + 0.5(1) \\ &= 0.681 \end{aligned}$$

for  $j=4$

$$\begin{aligned} \text{when } i=1 &\rightarrow U_{1,4} = 0.5(U_{0,4}) + 0.5(U_{2,4}) \\ &= 0.5(0.2098) \\ &= 0.1049 \end{aligned}$$

$$\begin{aligned} \text{when } i=2 &\rightarrow U_{2,4} = 0.5(U_{1,4}) + 0.5(U_{3,4}) \\ &= 0.5(0.1049) + 0.5(0.4158) \\ &= 0.2514 \end{aligned}$$

$$\begin{aligned} \text{when } i=3 &\rightarrow U_{3,5} = 0.5(U_{2,4}) + 0.5(U_{4,4}) \\ &= 0.5(0.2514) + 0.5(0.681) \\ &= 0.4454 \end{aligned}$$



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

~~At~~  $\frac{1}{\text{Temp}(x)}$

0.1	5	0	0.649	0.2514	0.4454	0.7079	1
0.08	4	0	0.0870	0.2098	0.4158	0.6810	1
0.06	3	0	0.0576	0.1740	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	0.4098	1
		0	0.2	0.4	0.6	0.8	1
	i	0	1	2	3	4	5