To find the temperature within the condition gradient, we use the discritized forward Euler method.

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

where

$$r = \frac{C\Delta t}{\Delta x^2} = \frac{1 \times 0.02}{(0.2)^2} = 0.5$$

Evaluating U at t = 0.02 i.e. j = 0, i = 1, 2, 3, 4

$U_{0,1} = 0$ (BC)

$U_{5,1} = 1K$

at i = 1

$U_{1,1} = rU_{0,0} + (1-2r)U_{1,0} + rU_{2,0}$

$= 0.5(0) + (1-2(0.5))0.0016 + 0.5(0.0256)$

$= 0 + 0 + 0.128$

$= 0.0128$

at i = 3

$U_{3,1} = rU_{2,0} + (1-2r)U_{3,0} + rU_{4,0}$

$= 0.5(0.0256) + (1-2(0.5))(0.1296) +$

$0.5(0.4096)$

$= 0.2176$

at i = 2

$U_{2,1} = rU_{1,0} + (1-2r)U_{2,0} + rU_{3,0}$

$= 0.5(0.0016) + (0)(0.0256) + 0.5(0.126)$

$= 0.0656$

at i = 4

$U_{4,1} = rU_{3,0} + (1-2r)U_{4,0} + rU_{5,0}$

$= 0.5(0.1296) + (1-2(0.5))(0.4096)$

$+ 0.5(1)$

$= 0.5648$

$\therefore U_{1,1}, U_{2,1}, U_{3,1}, U_{4,1} = 0.0128, 0.0656, 0.2176, 0.5648$

Evaluating U at t = 0.04, i.e. j = 1

at i = 1

$U_{1,2} = rU_{0,1} + (1-2r)U_{1,1} + rU_{2,1}$

$= 0.5(0) + (0)(0.0128) +$

$0.5(0.0656)$

$= 0.0328$

at i = 2

$U_{2,2} = rU_{1,1} + (1-2r)U_{2,1} + rU_{3,1}$

$= 0.5(0.0128) + (0)(0.0656) +$

$0.5(0.2176)$

$= 0.1152$

at $i=3$

$U_{3,2} = rU_{2,1} + (1-2r)U_{3,1} + rU_{4,1}$
$= 0.5(0.0656) + 0(0.2176) + 0.5(0.5648)$
$= 0.3152$

at $i=4$

$U_{4,2} = rU_{3,1} + (1-2r)U_{4,1} + rU_{5,1}$
$= 0.5(0.2176) + 0(0.5648) + 0.5(1)$
$= 0.6088$

N/B:- $U_{0,2} = 0$ \$ $U_{5,2} = 1$ (due to Boundary Condition)

Evaluating U at $t=0.06$ i.e $j=2$

at $i=1$

$U_{1,3} = rU_{0,2} + (1-2r)U_{1,2} + rU_{2,2}$
$= 0.5(0) + (0)(0.0328) + 0.5(0.1152)$
$= 0.0576$

at $i=3$

$U_{3,3} = rU_{2,2} + (1-2r)U_{3,2} + rU_{4,2}$
$= 0.5(0.1152) + (0)(0.3152) + 0.5(0.6088)$
$= 0.3620$

at $i=2$

$U_{2,3} = rU_{1,2} + (1-2r)U_{2,2} + rU_{3,2}$
$= 0.5(0.0328) + (0)(0.1152) + 0.5(0.3152)$
$= 0.1740$

at $i=4$

$U_{4,3} = rU_{3,2} + (1-2r)U_{4,2} + rU_{5,2}$
$= 0.5(0.3152) + 0(0.6088) + 0.5(1)$
$= 0.6576$

N/B:- $U_{0,3} = 0$ \$ $U_{5,3} = 1$

Evaluating U at $t=0.08$ i.e $j=3$

Noted before:- $U_{0,4} = 0$ \$ $U_{5,4} = 1$

at $i=1$

$U_{1,4} = rU_{0,3} + (1-2r)U_{1,3} + rU_{2,3}$
$= 0.5(0) + 0(0.0576) + 0.5(0.1740)$
$= 0.087$

at $i=2$

$U_{2,4} = rU_{1,3} + (1-2r)U_{2,3} + rU_{3,3}$
$= 0.5(0.0576) + 0(0.1740) + 0.5(0.362)$
$= 0.2098$

at $i=3$

$U_{3,4} = rU_{2,3} + (1-2r)U_{3,3} + rU_{4,3}$
$= 0.5(0.194) + 0(0.362) + 0.5(0.6576)$
$= 0.4158$

at $i=4$

$U_{4,4} = rU_{3,3} + (1-2r)U_{4,3} + rU_{5,3}$
$= 0.5(0.362) + 0(0.6576) + 0.5(1)$
$= 0.681$

Evaluating U at t=1, j=4

at $i=1$

$U_{1,5} = rU_{0,4} + (1-2r)U_{1,4} + rU_{2,4}$
$= 0.5(0) + 0(0.087) + 0.5(0.2098)$
$= 0.1049$

at $i=2$

$U_{2,5} = rU_{1,4} + (1-2r)U_{2,4} + rU_{3,4}$
$= 0.5(0.087) + 0(0.2098) + 0.5(0.4158)$
$= 0.0435 + 0 + 0.2079$
$= 0.2514$

at $i=3$

$U_{3,5} = rU_{2,4} + (1-2r)U_{3,4} + rU_{4,4}$
$= 0.5(0.2098) + 0(0.4158) + 0.5(0.681)$
$= 0.4454$

at $i=4$

$U_{4,5} = rU_{3,4} + (1-2r)U_{4,4} + rU_{5,4}$
$= 0.5(0.4158) + 0(0.681) + 0.5(1)$
$= 0.7079$

N/B: $U_{0,5} = 0$ & $U_{5,5} = 1$

t \ x	0	0.2	0.4	0.6	0.8	1
0	0	0.0016	0.0256	0.1296	0.4096	1
0.02	0	0.0128	0.0656	0.2176	0.5648	1
0.04	0	0.0328	0.1152	0.3152	0.6088	1
0.06	0	0.0596	0.194	0.362	0.6576	1
0.08	0	0.087	0.2098	0.4158	0.681	1
0.1	0	0.1049	0.2514	0.4454	0.7079	1

TABULAR FORM.

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17/ENG01/015
CHEMICAL ENGINEERING
Maths Assignment

Using explicit forward difference method

$$U_t = c\,U_{xx} \quad \text{for } 0 \leq x \leq 1m,\ 0 \leq t \leq 0.1\text{day}$$

$\Delta x = 0.2m$

$\therefore U_t = CU_{xx}$

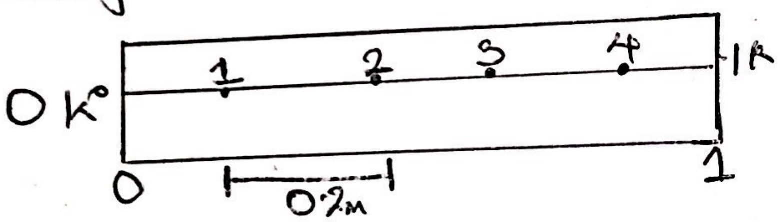
Initial Condition

$$U(x,0) = x^4 K = f(x)$$

Boundary Condition

$$U(0,t) = 0K \rightarrow U(1,t) = 1K$$

Graphically



Since it is at Boundary Condition, we use the function of x

At $t=0$

$$U_{a,0} = 0^{\circ}$$

when $x = 0.2m$

$$U_{1,0} = (0.2)^4 = 0.0016$$

when $x=0.4m$

$$U_{2,0} = (0.4)^4 = 0.0256$$

when $x=0.8m$

$$U_{4,0} = (0.8)^4 = 0.4016$$

when $x=0.6m$

$$U_{3,0} = (0.6)^4 = 0.1296$$

when $x=1$

$$U_{5,0} = (1)^4 = 1$$

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	0	0.2	0.4	0.6	0.8	1
0	0	0.0016	0.0256	0.1296	0.4096	1
0.02	0	0.0128	0.0656	0.2176	0.5648	1
0.04	0	0.0528	0.1152	0.3152	0.6088	1
0.06	0	0.0576	0.174	0.362	0.6576	1
0.08	0	0.087	0.2098	0.4158	0.681	1
0.1	0	0.1049	0.2514	0.4454	0.7079	1