

Buller, Florence Ilueh-Ochuwah

16/ENG01/005

chemical engineering

ENG 382 - Engineering Mathematics IV

Assignment 7

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

where $r = \frac{C \Delta t}{(\Delta x)^2}$

Given, $C = 2.2 \text{ cm}^2/\text{hr}$

$\Delta t = 0.02 \text{ hr}$

$\Delta x = 0.3 \text{ cm}$

$T(x,0) = 3x^2$

$T(0,t) = 0$

$T(L,t) = 108$

$$r = \frac{2.2 \times 0.02}{(0.3)^2} ; r = 0.48889$$

$\bar{i} = 0, j = 1$

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

~~$u_{0,2} = 0$~~

Applying boundary conditions, $u_{0,1} = 3x^2 = 3(0)^2 = 0$

$\therefore u_{0,1} ; u_{0,16} = 0$

$u_{1,1} = 3x^2 = 3(0.3)^2 = 0.27$

$u_{2,1} = 3x^2 = 3(0.6)^2 = 1.08$

$u_{3,1} = 3x^2 = 3(0.9)^2 = 2.43$

$u_{4,1} = 3x^2 = 3(1.2)^2 = 4.32$

$u_{5,1} = 3x^2 = 3(1.5)^2 = 6.75$

$u_{6,1} = 3x^2 = 3(1.8)^2 = 9.72$

$u_{7,1} = 3x^2 = 3(2.1)^2 = 13.23$

$u_{8,1} = 3x^2 = 3(2.4)^2 = 17.28$

$u_{9,1} = 3x^2 = 3(2.7)^2 = 21.87$

$u_{10,1} = 3x^2 = 3(3)^2 = 27$

$u_{11,1} = 3x^2 = 3(3.3)^2 = 32.67$

$u_{12,1} = 3x^2 = 3(3.6)^2 = 38.88$

$u_{13,1} = 3x^2 = 3(3.9)^2 = 45.63$

$u_{14,1} = 3x^2 = 3(4.2)^2 = 52.92$

$u_{15,1} = 3x^2 = 3(4.5)^2 = 60.75$

$$u_{16,1} = 3x^2 = 3(4.8)^2 = 69.12$$

$$u_{12,1} = 3x^2 = 3(5.1)^2 = 78.03$$

$$u_{14,1} = 3x^2 = 3(5.4)^2 = 87.48$$

$$u_{17,1} = 3x^2 = 3(5.7)^2 = 97.47$$

$$u_{20,1} = 3x^2 = 3(6)^2 = 108$$

when $i=1, j=1$

$$u_{1,2} = ru_{0,1} + (1-2r)u_{1,1} + ru_{2,1}$$

$$u_{1,2} = (0.48889 \times 0) + [1 - (2 \times 0.48889)]0.27 + (0.48889 \times 1.08)$$

$$u_{1,2} = 0.534006$$

$$u_{2,2} = ru_{1,2} + (1-2r)u_{2,1} + ru_{3,1}$$

$$u_{2,2} = (0.48889 \times 0.27) + [1 - (2 \times 0.48889)]1.08 + (0.48889 \times 2.43)$$

$$u_{2,2} = 1.344006$$

$$u_{3,2} = ru_{2,2} + (1-2r)u_{3,1} + ru_{4,1}$$

$$u_{3,2} = (0.48889 \times 1.08) + [1 - (2 \times 0.48889)]2.43 + (0.48889 \times 4.32)$$

$$u_{3,2} = 2.694006$$

$$u_{4,2} = ru_{3,2} + (1-2r)u_{4,1} + ru_{5,1}$$

$$u_{4,2} = (0.48889 \times 2.43) + [1 - (2 \times 0.48889)]4.32 + (0.48889 \times 6.75)$$

$$u_{4,2} = 4.584006$$

$$u_{5,2} = ru_{4,2} + (1-2r)u_{5,1} + ru_{6,1}$$

$$u_{5,2} = (0.48889 \times 4.32) + [1 - (2 \times 0.48889)]6.75 + (0.48889 \times 9.72)$$

$$u_{5,2} = 7.014006$$

$$u_{6,2} = ru_{5,2} + (1-2r)u_{6,1} + ru_{7,1}$$

$$u_{6,2} = (0.48889 \times 6.75) + [1 - (2 \times 0.48889)]9.72 + (0.48889 \times 13.23)$$

$$u_{6,2} = 9.984006$$

$$u_{7,2} = r u_{6,1} + (1-2r) u_{7,1} + r u_{8,1}$$

$$u_{7,2} = (0.48889 \times 9.72) + [1 - (2 \times 0.48889)] 13.23 + (0.48889 \times 17.28)$$

$$u_{7,2} = 13.494006$$

$$u_{8,2} = r u_{7,1} + (1-2r) u_{8,1} + r u_{9,1}$$

$$u_{8,2} = (0.48889 \times 13.23) + [1 - (2 \times 0.48889)] 17.28 + (0.48889 \times 21.87)$$

$$u_{8,2} = 17.544006$$

$$u_{9,2} = r u_{8,1} + (1-2r) u_{9,1} + r u_{10,1}$$

$$u_{9,2} = (0.48889 \times 17.28) + [1 - (2 \times 0.48889)] 21.87 + (0.48889 \times 27)$$

$$u_{9,2} = 22.134006$$

$$u_{10,2} = r u_{9,1} + (1-2r) u_{10,1} + r u_{11,1}$$

$$u_{10,2} = (0.48889 \times 21.87) + [1 - (2 \times 0.48889)] 27 + (0.48889 \times 32.67)$$

$$u_{10,2} = 27.2640006$$

$$u_{11,2} = r u_{10,1} + (1-2r) u_{11,1} + r u_{12,1}$$

$$u_{11,2} = (0.48889 \times 27) + [1 - (2 \times 0.48889)] 32.67 + (0.48889 \times 38.88)$$

$$u_{11,2} = 32.9340006$$

$$u_{12,2} = r u_{11,1} + (1-2r) u_{12,1} + r u_{13,1}$$

$$u_{12,2} = (0.48889 \times 32.67) + [1 - (2 \times 0.48889)] 38.88 + (0.48889 \times 45.63)$$

$$u_{12,2} = 39.1440006$$

$$u_{13,2} = r u_{12,1} + (1-2r) u_{13,1} + r u_{14,1}$$

$$u_{13,2} = (0.48889 \times 38.88) + [1 - (2 \times 0.48889)] 45.63 + (0.48889 \times 52.92)$$

$$u_{13,2} = 45.8940006$$

$$u_{14,2} = r u_{13,1} + (1-2r) u_{14,1} + r u_{15,1}$$

$$u_{14,2} = (0.48889 \times 45.63) + [1 - (2 \times 0.48889)] 52.92 + (0.48889 \times 60.75)$$

$$u_{14,2} = 53.1840006$$

$$U_{15,2} = rU_{14,1} + (1-2r)U_{15,1} + rU_{16,1}$$

$$U_{15,2} = (0.48889 \times 52.92) + [1 - (2 \times 0.48889)]60.75 + (0.48889 \times 69.12)$$

$$U_{15,2} = 61.0190006$$

$$U_{16,2} = rU_{15,1} + (1-2r)U_{16,1} + rU_{17,1}$$

$$U_{16,2} = (0.48889 \times 60.75) + [1 - (2 \times 0.48889)]69.12 + (0.48889 \times 78.03)$$

$$U_{16,2} = 69.3840006$$

$$U_{17,2} = rU_{16,1} + (1-2r)U_{17,1} + rU_{18,1}$$

$$U_{17,2} = (0.48889 \times 69.12) + [1 - (2 \times 0.48889)]78.03 + (0.48889 \times 87.48)$$

$$U_{17,2} = 78.2940006$$

$$U_{18,2} = rU_{17,1} + (1-2r)U_{18,1} + rU_{19,1}$$

$$U_{18,2} = (0.48889 \times 78.03) + [1 - (2 \times 0.48889)]87.48 + (0.48889 \times 97.47)$$

$$U_{18,2} = 87.7490006$$

$$U_{19,2} = rU_{18,1} + (1-2r)U_{19,1} + rU_{20,1}$$

$$U_{19,2} = (0.48889 \times 87.48) + [1 - (2 \times 0.48889)]97.47 + (0.48889 \times 108)$$

$$U_{19,2} = 97.7390006$$

$U_{20,2}$; applying boundary condition $T(L,t) = 108$

; $T(b,t) = 108$

$$\therefore T_{20,1} = T_{20,16} = 108$$

Buller, Florence Iweh-Ochuwah

16/ENG01/005

Chemical Engineering

ENG 382 - Engineering Mathematics IV

Assignment 2

<u>t</u>	<u>0</u>	<u>0.02</u>
<u>n</u>		
<u>0</u>	<u>0</u>	<u>0</u>
<u>0.3</u>	<u>0.27</u>	<u>0.534006</u>
<u>0.6</u>	<u>1.08</u>	<u>1.344006</u>
<u>0.9</u>	<u>2.43</u>	<u>2.694006</u>
<u>1.2</u>	<u>4.32</u>	<u>4.584006</u>
<u>1.5</u>	<u>6.75</u>	<u>7.014006</u>
<u>1.8</u>	<u>9.72</u>	<u>9.984006</u>
<u>2.1</u>	<u>13.23</u>	<u>13.494006</u>
<u>2.4</u>	<u>17.28</u>	<u>17.544006</u>
<u>2.7</u>	<u>21.87</u>	<u>22.134006</u>
<u>3.0</u>	<u>27</u>	<u>27.264006</u>
<u>3.3</u>	<u>32.67</u>	<u>32.934006</u>
<u>3.6</u>	<u>38.88</u>	<u>39.144006</u>
<u>3.9</u>	<u>45.63</u>	<u>45.894006</u>
<u>4.2</u>	<u>52.92</u>	<u>53.184006</u>
<u>4.5</u>	<u>60.75</u>	<u>61.014006</u>
<u>4.8</u>	<u>69.12</u>	<u>69.384006</u>
<u>5.1</u>	<u>78.03</u>	<u>78.294006</u>
<u>5.4</u>	<u>87.48</u>	<u>87.744006</u>
<u>5.7</u>	<u>97.47</u>	<u>97.734006</u>
<u>6.0</u>	<u>108</u>	<u>108</u>

BULLEM, FLORENCE ILUEH-OCHUWEH

16/ENG01/005

CHEMICAL ENGINEERING

ENG 382- ENGINEERING MATHEMATICS IV

ASSIGNMENT 7

```
commandwindow
clear
clc
close all
format short g
t0 = 0;
l0 = 0;
tf = 0.3;
lf = 6;
dl = 0.3;
dt = 0.02;
c = 2.2;
r = c*(dt/(dl^2));
t = [t0:dt:tf]';
l = [l0:dl:lf]
n = (lf-l0)/dl
m = (tf-t0)/dt
T(1:m+1,1) = zeros(m+1,1);
T(1:m+1,n+1) = 108;
T(1,1:n+1) = 3*(l.^2);
for j = 1:m
    for i = 2:n
        T(j+1,i) = r*T(j,i-1) + (1-(2*r))*T(j,i) + r*T(j,i+1);
    end
end
end
T
```

```
subplot(1,2,1)
mesh(l,t,T)
subplot(1,2,2)
surf(l,t,T)
```

RESULTS

t =

```
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
```

l =

Columns 1 through 9

```
1.8      0      0.3      0.6      0.9      1.2      1.5
      2.1      2.4
```

Columns 10 through 18

	2.7	3	3.3	3.6	3.9	4.2
4.5	4.8	5.1				

Columns 19 through 21

5.4	5.7	6
-----	-----	---

n =

20

m =

15

T =

Columns 1 through 9

	0	0.27	1.08	2.43	4.32	6.75
9.72	13.23	17.28				
	0	0.534	1.344	2.694	4.584	7.014
9.984	13.494	17.544				
	0	0.66893	1.608	2.958	4.848	7.278
10.248	13.758	17.808				
	0	0.801	1.8089	3.222	5.112	7.542
10.512	14.022	18.072				
	0	0.90215	2.007	3.4552	5.376	7.806
10.776	14.286	18.336				

	0	1.0012	2.1748	3.6862	5.6249	8.07
11.04	14.55	18.6				
	0	1.0855	2.34	3.8951	5.8725	8.3266
11.304	14.814	18.864				
	0	1.1681	2.487	4.1016	6.1056	8.5824
11.564	15.078	19.128				
	0	1.2418	2.6316	4.292	6.3367	8.8294
11.824	15.34	19.392				
	0	1.3141	2.7639	4.4799	6.5557	9.0749
12.079	15.602	19.655				
	0	1.3804	2.894	4.6558	6.7725	9.312
12.333	15.861	19.918				
	0	1.4455	3.0154	4.8293	6.9792	9.5473
12.581	16.12	20.179				
	0	1.5063	3.1347	4.9935	7.1837	9.7749
12.828	16.374	20.44				
	0	1.566	3.2474	5.1555	7.3798	10.001
13.069	16.628	20.699				
	0	1.6224	3.3582	5.31	7.5737	10.219
13.309	16.878	20.957				
	0	1.6779	3.4638	5.4625	7.7605	10.436
13.544	17.127	21.213				

Columns 10 through 18

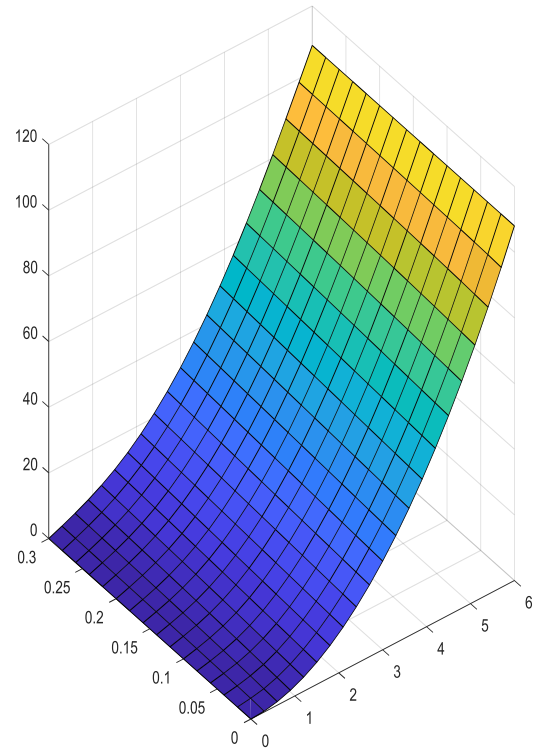
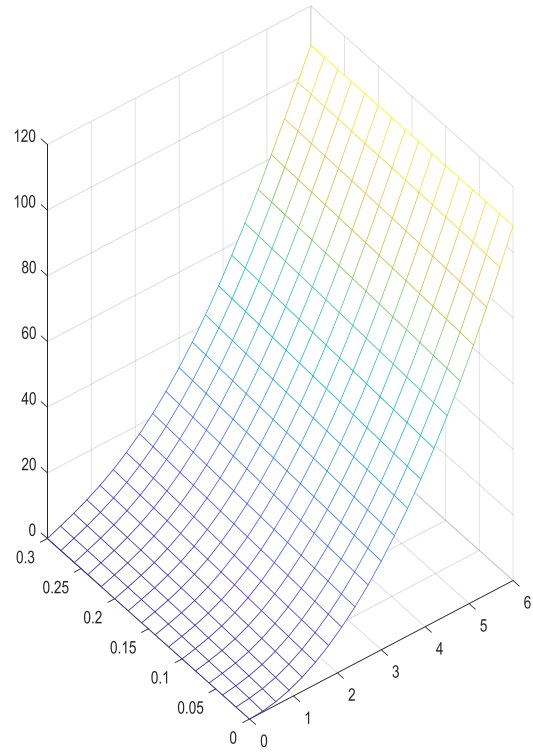
	21.87	27	32.67	38.88	45.63	52.92
60.75	69.12	78.03				
	22.134	27.264	32.934	39.144	45.894	53.184
61.014	69.384	78.294				
	22.398	27.528	33.198	39.408	46.158	53.448
61.278	69.648	78.558				
	22.662	27.792	33.462	39.672	46.422	53.712
61.542	69.912	78.822				

61.806	22.926	28.056	33.726	39.936	46.686	53.976
	70.176	79.055				
62.07	23.19	28.32	33.99	40.2	46.95	54.24
	70.425	79.286				
62.327	23.454	28.584	34.254	40.464	47.214	54.504
	70.672	79.495				
62.582	23.718	28.848	34.518	40.728	47.478	54.764
	70.906	79.702				
62.829	23.982	29.112	34.782	40.992	47.74	55.024
	71.137	79.892				
63.075	24.246	29.376	35.046	41.255	48.002	55.279
	71.356	80.08				
63.312	24.51	29.64	35.31	41.518	48.261	55.533
	71.572	80.256				
63.547	24.773	29.904	35.573	41.779	48.52	55.781
	71.779	80.429				
63.775	25.036	30.167	35.836	42.04	48.774	56.028
	71.984	80.594				
64.001	25.298	30.43	36.098	42.299	49.028	56.269
	72.18	80.756				
64.219	25.558	30.692	36.358	42.557	49.278	56.509
	72.374	80.91				
64.436	25.819	30.952	36.619	42.813	49.527	56.744
	72.561	81.062				

Columns 19 through 21

87.48	97.47	108
87.744	97.734	108
88.008	97.869	108
88.209	98.001	108
88.407	98.102	108
88.575	98.201	108
88.74	98.286	108

88.887	98.368	108
89.032	98.442	108
89.164	98.514	108
89.294	98.58	108
89.415	98.646	108
89.535	98.706	108
89.647	98.766	108
89.758	98.822	108
89.864	98.878	108



EXCEL SOLUTION

tf	0.3
lf	6
n	16
m	21
dt	0.02
dl	0.3
A	2.2
r	0.488889

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW

Clipboard: Cut, Copy, Paste, Format Painter

Font: Calibri, 11, Bold, Italic, Underline, Text Color, Background Color

Alignment: Wrap Text, Merge & Center, Indent, Orientation

Number: General, Percentage, Decimals

Styles: Conditional Formatting, Format as Table, Cell Styles

Cells: Insert, Delete, Format

Editing: AutoSum, Fill, Clear, Sort & Filter, Find & Select

SUM : X ✓ f $=($B$8*D12)+((1-(2*$B$8))*D13)+($B$8*D14)$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
10			t	0	0.02	0.04	0.06	0.08	0.1	0.12	0.14	0.16	0.18	0.2	0.22	0.24	0.26	0.28	0.3		
11			x																		
12			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13			0.3	0.27	$=($B$8*D12)+((1-(2*$B$8))*D13)+($B$8*D14)$					1.085504	1.168119	1.241813	1.314132	1.380431	1.445542	1.506294	1.566002	1.622395	1.677857		
14			0.6	1.08	1.344	1.608	1.808901	2.006997	2.174837	2.339993	2.486976	2.63155	2.763875	2.894044	3.01535	3.134718	3.247353	3.358235	3.463818		
15			0.9	2.43	2.694	2.958	3.222	3.455151	3.686246	3.89513	4.101553	4.291952	4.479874	4.655783	4.829319	4.993532	5.155508	5.31004	5.46248		
16			1.2	4.32	4.584	4.848	5.112	5.376	5.624918	5.872496	6.105581	6.33674	6.555688	6.772482	6.979177	7.18366	7.379752	7.573655	7.760514		
17			1.5	6.75	7.014	7.278	7.542	7.806	8.07	8.326627	8.582434	8.829376	9.074944	9.311966	9.547295	9.774886	10.00062	10.21948	10.43641		
18			1.8	9.72	9.984	10.248	10.512	10.776	11.04	11.304	11.5644	11.82431	12.07902	12.3328	12.58094	12.82783	13.06916	13.30903	13.54363		
19			2.1	13.23	13.494	13.758	14.022	14.286	14.55	14.814	15.078	15.34024	15.6022	15.86119	16.11959	16.3744	16.62835	16.87844	17.12745		
20			2.4	17.28	17.544	17.808	18.072	18.336	18.6	18.864	19.128	19.392	19.65514	19.91812	20.17945	20.4404	20.6991	20.9572	21.21263		
21			2.7	21.87	22.134	22.398	22.662	22.926	23.19	23.454	23.718	23.982	24.246	24.50958	24.77307	25.03555	25.29778	25.55842	25.8186		
22			3	27	27.264	27.528	27.792	28.056	28.32	28.584	28.848	29.112	29.376	29.64	29.90359	30.16708	30.42959	30.69182	30.95249		
23			3.3	32.67	32.934	33.198	33.462	33.726	33.99	34.254	34.518	34.782	35.046	35.30958	35.57307	35.83555	36.09778	36.35842	36.6186		
24			3.6	38.88	39.144	39.408	39.672	39.936	40.2	40.464	40.728	40.992	41.25514	41.51812	41.77945	42.0404	42.2991	42.5572	42.81263		
25			3.9	45.63	45.894	46.158	46.422	46.686	46.95	47.214	47.478	47.74024	48.0022	48.26119	48.51959	48.7744	49.02835	49.27844	49.52745		
26			4.2	52.92	53.184	53.448	53.712	53.976	54.24	54.504	54.7644	55.02431	55.27902	55.5328	55.78094	56.02783	56.26916	56.50903	56.74363		
27			4.5	60.75	61.014	61.278	61.542	61.806	62.07	62.32663	62.58243	62.82938	63.07494	63.31197	63.54729	63.77489	64.00062	64.21948	64.43641		
28			4.8	69.12	69.384	69.648	69.912	70.176	70.42492	70.6725	70.90558	71.13674	71.35569	71.57248	71.77918	71.98366	72.17975	72.37365	72.56051		
29			5.1	78.03	78.294	78.558	78.822	79.05515	79.28625	79.49513	79.70155	79.89195	80.07987	80.25578	80.42932	80.59353	80.75551	80.91004	81.06248		
30			5.4	87.48	87.744	88.008	88.2089	88.407	88.57484	88.73999	88.88698	89.03155	89.16388	89.29404	89.41535	89.53472	89.64735	89.75823	89.86382		
31			5.7	97.47	97.734	97.86893	98.001	98.10215	98.20125	98.2855	98.36812	98.44181	98.51413	98.58043	98.64554	98.70629	98.766	98.82239	98.87786		
32			6	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108		

3-D PLOT SHOWING RESULTS OBTAINED

