ASSIGNMENT III

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MECHANICAL ENGINEERING

ENG 382: ENGINEERING MATHEMATICS IV

Question:

If the model of a system having thermocouple measuring temperatures, T(°C), at its different point is given by the set of expressions in Equation (1), estimate the values of the temperatures using:

a. Gauss elimination method manually (with the aid of calculator),
b. Gauss elimination method with the aid of Microsoft Excel,
c. Gauss elimination method with the aid of MATLAB,
d. Matrix inverse method with the aid of microsoft Excel, and
e. Matrix inverse method with the aid of MATLAB

$$
\begin{cases}
T_1 + T_2 - 2T_3 + 3T_4 + 3T_5 - T_6 = 4 \\
2T_1 - T_2 + T_3 + 2T_4 + T_5 - 3T_6 = 20 \\
T_1 + 3T_2 - 3T_3 - T_4 + 2T_5 + T_6 = -15 \\
5T_1 + 2T_2 - T_3 - T_4 + 2T_5 + T_6 = -3 \\
-3T_1 - T_2 + 2T_3 + 3T_4 + T_5 + 3T_6 = 16 \\
4T_1 + 3T_2 + 4T_3 - 6T_4 - 3T_5 - 2T_6 = -27
\end{cases}
$$

Solution

a) The augmented matrix (1)

$$\tilde{A}^{(0)} = \left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 2 & -1 & 1 & 2 & 1 & -3 & 20 \\ 1 & 3 & -3 & -1 & 2 & 1 & -15 \\ 5 & 2 & -1 & -1 & 2 & 1 & -3 \\ -3 & -1 & 2 & 3 & 1 & 3 & 16 \\ 4 & 3 & 1 & -6 & -3 & -2 & -27 \end{array}\right]$$

$$\tilde{A}^{(2)} = \left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & -1.5 & 2.5 & 0 & -2.5 & -0.5 & 6 \\ 0 & 2 & -1 & -2 & -1 & 2 & -19 \\ 0 & -0.6 & 1.8 & -1.2 & -2.6 & 1.2 & -4.6 \\ 0 & -0.667 & 1.333 & -2 & -3.333 & 0 & -9.333 \\ 0 & -0.25 & 2.25 & -2.5 & -3.75 & 0.5 & -10.75 \end{array}\right]$$

$\frac{E_2}{2} - E_1 \Rightarrow$ $E_3 - E_1 \Rightarrow$ $\frac{E_4}{5} - E_1 \Rightarrow$ $\frac{E_5}{-3} - E_1 \Rightarrow$ $\frac{E_6}{4} - E_1 \Rightarrow$

Divide through E_3 by 2 and swap (pivot) with E_2

$$\hat{A}^{(2)} = \left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & 1 & -0.5 & -1 & -0.5 & 1 & -9.5 \\ 0 & -1.5 & 2.5 & 0 & -2.5 & -0.5 & 6 \\ 0 & -0.6 & 1.8 & -1.2 & -2.6 & 1.2 & -4.6 \\ 0 & -0.667 & 1.333 & -2 & -3.333 & 0 & -9.333 \\ 0 & -0.25 & 2.25 & -2.5 & -3.75 & 0.5 & -10.75 \end{array}\right]$$

$\tilde{A}^{(3)} =$

	1	1	-2	1	3	-1	4
	0	1	-0.5	-1	-0.5	1	-9.5
$\frac{E_3}{1.5} + E_2 \Rightarrow$	0	0	1.167	-1	-2.167	0.667	-5.5
$\frac{E_4}{0.6} + E_2 \Rightarrow$	0	0	2.5	-3	-4.833	3	-17.167
$\frac{E_5}{0.667} + E_2 \Rightarrow$	0	0	1.499	-3.999	-5.497	1	-23.493
$\frac{E_6}{0.25} + E_2 \Rightarrow$	0	0	8.5	-11	-15.5	3	-52.5

Divide through E_4 by 2.5 and swap with E_3

$\tilde{A}^{(3)} =$

	1	1	-2	1	3	-1	4
	0	1	-0.5	-1	-0.5	1	-9.5
	0	0	1	-1.2	-1.933	1.2	-6.867
	0	0	1.167	-1	-2.167	0.667	-5.5
	0	0	1.499	-3.999	-5.497	1	-23.493
	0	0	8.5	-11	-15.5	3	-52.5

$\tilde{A}^{(4)} =$

	1	1	-2	1	3	-1	4
	0	1	-0.5	-1	-0.5	1	-9.5
	0	0	1	-1.2	-1.933	1.2	-6.867
$\frac{E_4}{1.167} - E_3 \Rightarrow$	0	0	0	0.343	0.076	-0.628	2.154
$\frac{E_5}{1.499} - E_3 \Rightarrow$	0	0	0	-1.468	-1.784	-0.533	-8.805
$\frac{E_6}{8.5} - E_3 \Rightarrow$	0	0	0	-0.094	0.109	-0.847	0.691

Divide through E_4 by 0.343

$\tilde{A}^{(4)} =$

1	1	-2	1	3	-1	4
0	1	-0.5	-1	-0.5	1	-9.5
0	0	1	-1.2	-1.933	1.2	-6.867
0	0	0	1	0.222	-1.831	6.280
0	0	0	-1.468	-1.734	-0.533	-8.805
0	0	0	-0.094	0.109	-0.847	0.691

$\tilde{A}^{(5)} =$

1	1	-2	1	3	-1	4
0	1	-0.5	-1	-0.5	1	-9.5
0	0	1	-1.2	-1.933	1.2	-6.867
0	0	0	1	0.222	-1.831	6.280
$\frac{E5}{-1.468} - E4$	0	0	0	0	0.959	2.194	-0.282
$\frac{E6}{-0.094} - E4$	0	0	0	0	-1.382	10.842	-13.631

Divide through E5 by 0.959

$\tilde{A}^{(5)} =$

1	1	-2	1	3	-1	4
0	1	-0.5	-1	-0.5	1	-9.5
0	0	1	-1.2	-1.933	1.2	-6.867
0	0	0	1	0.222	-1.831	6.280
0	0	0	0	1	2.288	-0.294
0	0	0	0	-1.382	10.842	-13.631

$\hat{A}^{(6)} =$

1	1	-2	1	3	-1	4
0	1	-0.5	-1	-0.5	1	-9.5
0	0	1	-1.2	-1.983	1.2	-6.867
0	0	0	1	0.222	-1.831	6.280
0	0	0	0	1	2.288	-0.294
0	0	0	0	0	-10.133	10.157

$\frac{E6}{-1.382} - E5$

Backward substitution

$A^{\sim(6)}$ from E_6 ; $-10.133\,T_6 = 10.157$

$T_6 = -1.002 \approx -1$ //

from E_5 ; $T_5 + 2.288T_6 = -0.294$

$T_5 = -0.294 - 2.288(-1.002)$

$T_5 = 1.999 \approx 2$ //

from E_4 ; $T_4 + 0.222T_5 - 1.831T_6 = 6.280$

$T_4 = -0.222(1.999) + 1.831(-1.002) + 6.280$

$T_4 = 4.002 \approx 4$ //

from E_3 ; $T_3 - 1.2T_4 - 1.933T_5 + 1.2T_6 = -6.867$

$T_3 = +1.2(4.002) + 1.933(1.999) - 1.2(-1.002) - 6.867$

$T_3 = 3.002 \approx 3$ //

from E_2 ; $T_2 - 0.5T_3 - T_4 - 0.5T_5 + T_6 = -9.5$ (-9.5)

$T_2 = 0.5(3.002) + 4.002 + 0.5(1.999) + (-1.002)$.

$T_2 = -1.996 \approx -2$ //

from E_1;

$$I_1 + I_2 - 2I_3 + I_4 + 3I_5 - I_6 = 4$$

$$I_1 = 4 - (-1.996) + 2(3.002) - 4.002 - 3(1.999) + (-1.002)$$

$$I_1 = 0.999 \approx 1 \text{ A}$$

$\therefore I_1 = 1$, $I_2 = -2$, $I_3 = 3$

$I_4 = 4$, $I_5 = 2$ & $I_6 = -1$.

b.) Excel file attached to Zip folder.

c.) Matlab file attached to Zip folder.

MATLAB PROGRAM CODE

```
function C = assign3(A,B)
A = [1 1 -2 1 3 -1; 2 -1 1 2 1 -3; 1 3 -3 -1 2 1;
     5 2 -1 -1 2 1; -3 -1 2 3 1 3; 4 3 1 -6 -3 -2];
B = [4; 20; -15; -3; 16; -27];
i = 1;
X = [A B];
[m n] = size(X);
while i <= m
    if X(i,i) == 0
```

```
9-              disp ('Diagonal element zero')
10-             return
11-         end
12-         x = elimination (x,i,i);
13-         i = i+1;
14-     end
15-     c = x(:,n);

16- function x = elimination(x, i, j)
17-     [m n] = size(x);
18-     a = x(i,j);
19-     x(i,:) = x(i,:)/a;
20- for   k = 1:m
21-         if k == i
22-             continue
23-         end
24-         x(k,:) = x(k,:) - x(i,:) * x(k,j);
25- end
```

d.) Excel file attached to Zip folder.

e- Matlab file attached to zip file

MATLAB PROGRAM CODE.

```
commandwindow
clear
clc
close all
A = [1 1 -2 1 3 -1; 2 -1 1 2 1 -3; 1 3 -3 -1 2 1;
     5 2 -1 -1 2 1; -3 -1 2 3 1 3; 4 3 1 -6 -3 -2
x = [4; 20; -15; -3; 16; -27]
n = inv(A)
b = inv(A) * x
```