

Name: Ooolabi Daniel Olucalife
Department: Mechanical Engineering
Matrix No: 16/ENG06/062
Course Code: ENG 382
Date: 10/03/19

Assignment 3

If a model of a system having thermocouple measuring temperatures, $T(^{\circ}\text{C})$ at its different points is given by the set of expressions in equation (1)
Estimate the values of the temperature using

- Gauss elimination method manually (with the aid of a calculator)
- Gauss elimination with the aid of Microsoft Excel
- Gauss elimination method with the aid of MATLAB
- Matrix inverse method with the aid of Microsoft Excel
- Matrix inverse method with the aid of MATLAB

Solution

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

$$A^{(1)}_2 \left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 2 & -1 & 1 & 2 & 1 & -3 & 20 \\ 1 & 3 & -3 & -1 & 2 & 1 & -15 \\ 5 & 2 & -1 & -1 & 2 & 1 & -3 \\ -3 & -1 & 2 & 3 & 1 & 3 & 16 \\ 4 & 3 & 1 & -6 & -3 & -2 & -27 \end{array} \right]$$

$$A^{(2)}_2 \left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ E_2 - E_1 \rightarrow & 0 & -1.5 & 2.5 & 0 & -2.5 & -0.5 & 6 \\ E_3 - E_1 \rightarrow & 0 & 2 & -1 & -2 & -1 & 2 & -19 \\ E_4 - E_1 \rightarrow & 0 & -0.6 & 1.8 & -1.2 & -2.6 & 1.2 & -4.6 \\ E_5/3 - E_1 \rightarrow & 0 & -0.667 & 1.333 & -2 & -3.333 & 0 & -9.333 \\ E_6/4 - E_1 \rightarrow & 0 & -0.25 & 2.25 & -2.5 & -3.75 & 0.5 & -10.75 \end{array} \right]$$

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

$$A^{(2)}_2 \left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & 1 & -0.5 & -1 & -0.5 & 1 & -9.5 \\ 0 & -1.5 & 2.5 & 0 & -2.5 & -0.5 & 6 \\ 0 & -0.6 & 1.8 & -1.2 & -2.6 & 1.2 & -4.6 \\ 0 & -0.667 & 1.333 & -2 & -3.333 & 0 & -9.333 \\ 0 & -0.25 & 2.25 & -2.5 & -3.75 & 0.5 & -10.75 \end{array} \right]$$

$$A^{(3)}_2 \left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & 1 & -0.5 & -1 & -0.5 & 1 & -9.5 \\ E_3/1.5 - E_2 & 0 & 0 & 1.167 & -1 & -2.167 & 0.667 & -5.5 \\ E_4/0.6 - E_2 & 0 & 0 & 2.5 & -3 & -4.833 & 3 & -17.167 \\ -E_5/0.667 & 0 & 0 & 1.499 & -3.999 & -5.497 & 1 & -23.493 \\ & 0 & 0 & 8.5 & -11 & -15.5 & 3 & -52.5 \end{array} \right]$$

Divide through E_4 by 2.5 and Swap with E_3

$$A^{(3)}_2 \left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & 1 & -0.5 & -1 & -0.5 & 1 & -9.5 \\ 0 & 0 & 1 & -1.2 & -1.933 & 1.2 & -6.867 \\ 0 & 0 & 1.167 & -1 & -2.167 & 0.667 & -5.5 \\ 0 & 0 & 1.499 & -3.999 & -5.497 & 1 & -23.493 \\ 0 & 0 & 8.5 & -11 & -15.5 & 3 & -52.5 \end{array} \right]$$

$$A^{(4)} = \begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & 1 & -0.5 & -1 & -0.5 & 1 & -9.5 \\ 0 & 0 & 1 & -1.2 & -1.933 & 1.2 & -6.867 \\ E_4 / 0.343 & 0 & 0 & 0 & 0.343 & 0.076 & -0.628 & 2.154 \\ E_5 / 4.99 & 0 & 0 & 0 & -1.463 & -1.734 & -5.333 & -8.805 \\ E_6 / 8.5 & 0 & 0 & 0 & -0.094 & 0.104 & -0.847 & 0.891 \end{bmatrix}$$

Divide through E_4 by 0.343

$$A^{(4)} = \begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & 1 & -0.5 & -1 & -0.5 & 1 & -9.5 \\ 0 & 0 & 1 & -1.2 & -1.933 & 1.2 & -6.867 \\ 0 & 0 & 0 & 1 & 0.222 & -1.831 & 6.280 \\ E_4 / 0.959 & 0 & 0 & 0 & 0.959 & 2.194 & -0.282 \\ E_6 / 0.094 & 0 & 0 & 0 & -1.382 & 10.842 & -13.631 \end{bmatrix}$$

Divide through E_5 by 0.959

$$A^{(5)} = \begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & 1 & -0.5 & -1 & -0.5 & 1 & -9.5 \\ 0 & 0 & 1 & -1.2 & -1.933 & 1.2 & -6.867 \\ 0 & 0 & 0 & 1 & 0.222 & -1.831 & 6.280 \\ 0 & 0 & 0 & 0 & 1 & 2.288 & -0.294 \\ 0 & 0 & 0 & 0 & -1.382 & 10.842 & -13.63 \end{bmatrix}$$

$$A^{(6)} = \begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & 1 & -0.5 & -1 & -0.5 & 1 & -9.5 \\ 0 & 0 & 1 & -1.2 & -1.933 & 1.2 & -6.867 \\ 0 & 0 & 0 & 1 & 0.222 & -1.831 & 6.280 \\ 0 & 0 & 0 & 0 & 1 & 2.288 & -0.294 \\ 0 & 0 & 0 & 0 & 0 & -10.133 & 10.157 \end{bmatrix}$$

Backward Substitution

From E_6 in $A^{-1}(C)$: $-10.133T_6 = 10.157$

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

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 :

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

$$T_4 = 4.002 \approx 4$$

From E_3 :

$$T_3 = 1.2(4.002) + 1.933(1.999) - 1.2(-1.002) - 0.867$$

$$T_3 = 3.002 \approx 3$$

From E_2 :

$$T_2 = 0.5(3.002) + 4.002 + 0.5(1.999) - (-1.002) - 9.5$$

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

From E_1 :

$$T_1 = 4 - (-1.996) + 2(3.002) - 4.002 - 3(1.999) + (-1.002)$$

$$T_1 = 0.999 \approx 1$$

$$\therefore T_1 = 1, T_2 = -2, T_3 = 3, T_4 = 4, T_5 = 2 \text{ and } T_6 = -1$$

Matlabs program Codes

function C = assign3(A,B)

```
A = [11 -2 3 -1; 2 -1 2 1 -3; 13 -3 -1 2 1; 5 2 -1 -1 2 1;  
-3 -1 2 3 13; 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
```

```
disp('Diagonal element Zero')
```

```
return
```

```
end
```

```
X X = X(i,n);
```

function X = elimination(X, i, j)

```
[m, n] = size(X);
```

```
a = X(i,j)
```

```
X(i,:) = X(i,:) / a;
```

```
for k = 1:n
```

```
if k == i
```

```
continue
```

```
end
```

```
X(k,i) = X(k,i) - X(i,i) * X(k,j);
```

```
End
```

Matlab program Code

1- Command Window

2- Clear

3- Clc

4- Closeall

5- $A = \begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 & 2 & 1 & -1 & 2 & 1 & -3 & 1 & 3 & -3 & -1 & 2 & 1 & 5 & 2 & 1 & -1 & 2 & 1 & -3 & -1 & 2 & 3 & 1 & 3 & 4 & 3 & 1 & -6 & -3 & -2 \end{bmatrix}$

6- $X = \begin{bmatrix} 4 & 20 & -15 & -3 & 16 & -27 \end{bmatrix}$

7- $\text{inv}(A)$

8- $b = \text{inv}(A) * x$