UYAEBO Ebubechukwu
15/ENG04/059
Elect/Elect Engineering
ENG 382

If the model of a System of a system having thermocouples measuring temperature T (°C) at its different points is given by the set of expressions in equation 1, estimate the values of the temperatures using.

i. Gauss elimination method.

ii: Gauss elimination method with the aid of excel

iii Matrix Inverse method with aid of excel.

iv Matrix Inverse method with the aid of MATLAB.

$$\begin{cases} T_1 + T_2 - 2T_3 + T_4 + 3T_5 - T_6 = 4 \\ 2T_1 - T_2 + T_3 + 2T_4 + T_6 - 3T_6 = 20 \\ T_1 + 3T_2 - 3T_3 - T_4 + 2T_5 + T_6 = -15 \\ 5T_1 + 2T_2 - T_3 - T_4 + 2T_5 + T_6 = -3 \\ -3T_1 - T_2 + 2T_3 + 3T_4 + T_5 + 3T_6 = 16 \\ 4T_1 + 3T_2 + T_3 - 6T_4 - 3T_5 - 2T_6 = -27 \end{cases} \quad \text{---(1)}$$

Sol

$$\begin{pmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 2 & -1 & 1 & 2 & 1 & -3 \\ 1 & 3 & -3 & 1 & 2 & 1 \\ 5 & 2 & -1 & -1 & 2 & 1 \\ -3 & -1 & 2 & 3 & 1 & 3 \\ 4 & 3 & 1 & -6 & -3 & -2 \end{pmatrix} \begin{pmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{pmatrix} = \begin{pmatrix} 4 \\ 20 \\ -15 \\ -3 \\ 16 \\ -27 \end{pmatrix}$$

$$\begin{matrix} 1 & 1 & -2 & 1 & 3 & -1 & -4 \\ (2-(\frac{2}{1})\times 1 & (-1-(\frac{2}{1})\times 1 & (1-(\frac{2}{1})\times -2 & (2-(\frac{2}{1})\times 1) & (1-\frac{2}{1})\times 3) & (-3-(\frac{3}{1}\times -1 & 20-(\frac{2}{1})\times 4 \\ 1-(\frac{1}{1})\times 1 & (3-(\frac{1}{1})\times 1 & (-3-(\frac{1}{1})\times -2 & (-1-(\frac{1}{1})\times 1 & (2-(\frac{1}{1})\times 3 & (1-(\frac{1}{1})\times -1 & -15-(\frac{1}{1})\times 4 \\ 5-(\frac{5}{1})\times 1 & 2-(\frac{5}{1})\times 1 & (-1-(\frac{5}{1})\times -2) & (-1-(\frac{5}{1}\times 1) & (2-(\frac{5}{1})\times 3 & (1-(\frac{5}{1})\times -1 & -3-(\frac{5}{1})\times \\ (-3-(\frac{-3}{1})\times 1 & -1-(\frac{-3}{1})\times 1 & (2-(\frac{-3}{1})\times -2) & (3-(\frac{-3}{1})\times 4 & 1-(\frac{-3}{1})\times 3 & (3-(\frac{3}{1})\times -1 & 16-(\frac{-1}{1})\times \\ 4-(\frac{4}{1})\times 1 & (3-\frac{4}{1}\times 1) & (1-\frac{4}{1})\times 2 & -6-\frac{4}{1})\times 1 & -3-(\frac{4}{1})\times 3 & (-2-(\frac{4}{1})\times -1 & -27-(\frac{4}{1}) \end{matrix}$$

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$$= \left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & -3 & 5 & 0 & -5 & -1 & 12 \\ 0 & 2 & -1 & -2 & -1 & 2 & -19 \\ 0 & -3 & 9 & -6 & -13 & 6 & -23 \\ 0 & 2 & -4 & 6 & 10 & 0 & 28 \\ 0 & -1 & 9 & -10 & -15 & 2 & -43 \end{array}\right]$$

Done with Excel

$$= \left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & -3 & 5 & 0 & -5 & -1 & 12 \\ 0 & 0 & 2.33 & -2 & -4.33 & 1.33 & -11 \\ 0 & 0 & 4 & -6 & -8 & 7 & -35 \\ 0 & 0 & -0.67 & 6 & 6.667 & -0.67 & 36 \\ 0 & 0 & 7.33 & 10 & -13.33 & 2.33 & -47 \end{array}\right]$$

Done with Excel

$$\left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & -3 & 5 & 0 & -5 & -1 & 12 \\ 0 & 0 & 2.33 & -2 & -4.33 & 1.33 & -11 \\ 0 & 0 & 0 & -2.57 & -0.57 & 4.71 & -16.14 \\ 0 & 0 & 0 & 5.42 & 5.42 & -0.28 & 32.85 \\ 0 & 0 & 0 & -3.71 & 0.28 & -1.85 & -12.43 \end{array}\right]$$

Done with Excel

$$\left[\begin{array}{cccccc|c} 1 & 1 & -2 & 1 & 3 & -1 & 4 \\ 0 & -3 & 5 & 0 & -5 & -1 & 12 \\ 0 & 0 & 2.33 & -2 & -4.33 & 1.33 & -11 \\ 0 & 0 & 0 & -2.57 & -6.57 & 4.71 & -16.14 \\ 0 & 0 & 0 & 0 & 4.22 & 9.67 & -1.22 \\ 0 & 0 & 0 & 0 & 1.11 & -8.67 & 10.89 \end{array}\right]$$

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Done with Excel

1	1	-2	1	3	-1	1	4
0	-3	5	0	-5	-1	1	12
0	0	2.33	-2	-4.33	1.33	1	-11
0	0	0	-2.57	-0.57	4.71	1	-16.14
0	0	0	0	4.22	9.67	1	-1.22
0	0	0	0	0	-11.21	1	11.21

Final

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 0 & 2.33 & -2 & -4.33 & 1.33 \\ 0 & 0 & 0 & 2.57 & -0.57 & 4.71 \\ 0 & 0 & 0 & 0 & 4.22 & 9.67 \\ 0 & 0 & 0 & 0 & 0 & -11.21 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{bmatrix} = \begin{bmatrix} 4 \\ 12 \\ -11 \\ -16.14 \\ -1.22 \\ 11.21 \end{bmatrix}$$

$$-11.21 \times T_6 = 11.21$$

$$T_6 = -1$$

ii. $4.22 T_5 + 9.67 T_6 = -1.22$

$$4.22 T_5 + 9.67(-1) = -1.22$$

$$T_5 = \frac{-1.22 + 9.67}{4.22}$$

$$T_5 = 2$$

iii. $2.57 T_4 = -16.14 + 0.57(2) + 4.71(-1)$

$$T_4 = \frac{-16.14 + 0.57(2) + 4.71}{-2.57}$$

$$T_4 = 4$$

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iv) $2.33T_3 - 2T_4 - 4.33T_5 + 1.33T_6 = -11$

$2.33T_3 = -11 + 2T_4 + 4.33T_5 - 1.33T_6$

$T_3 = \frac{-11 + 2(4) + 4.33(2) - 1.33(-1)}{2.33}$

$T_3 = 3$

v) $-3T_2 + 5T_3 + 0T_4 - 5T_5 - 1T_6 = 12$

$T_2 = \frac{12 - 5T_3 - 5T_5 - T_6}{-3}$

$T_2 = \frac{12 - 5(3) - 5(2) - (-1)}{-3}$

$T_2 = -2.$

$= T_1 + T_2 - 2T_3 + T_4 + 3T_5 - T_6 = 4$

$T_1 = 4 - T_2 - 2T_3 - T_4 - 3T_5 + T_6$

$T_1 = 4 - (-2) + 2(3) - 4 - 3(2) + (-1)$

$= 4 + 2 + 6 - 4 - 6 - 1$

$= 1$

$$\begin{pmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{pmatrix} = \begin{pmatrix} 1 \\ -2 \\ 3 \\ 4 \\ 2 \\ 1 \end{pmatrix}$$

$T_1 = 1$

$T_2 = -2$

$T_3 = 3$

$T_4 = 4$

$T_5 = 2$

$T_6 = 1$

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