

Engineering Mathematics II

17 Ensoil 101 Mechanical Engineering

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Assignment 3

Given

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

Using Elimination (Gaussian method)

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

Multiply 1 through by $\frac{2}{1} \rightarrow 2$:

$$2 + 2 - 4 + 2 + 6 - 2 \mid 8$$

Subtract from 2

$$2 - 1 - 1 + 2 + 1 - 3 \mid 20$$

$$2 + 2 - 4 + 2 + 6 - 2 \mid 8$$

$$0 - 3 + 5 + 0 - 5 - 1 \mid 12$$

Multiply 1 through by $\frac{1}{1} \rightarrow 1$:

$$1 + 3 - 3 - 1 + 2 + 1 \mid -15$$

$$1 + 1 - 2 + 1 + 3 - 1 \mid 4$$

$$0 + 2 - 1 - 2 - 1 + 2 \mid -19$$

Multiply 1 through by $\frac{5}{1} \rightarrow 5$:

$$5 + 5 - 10 + 5 + 15 - 5 \mid 20$$

Subtract from 4

$$5 + 2 - 1 - 1 + 2 + 1 \quad | \quad -3$$

$$5 + 5 - 10 + 5 + 15 - 5 \quad | \quad 20$$

$$0 - 3 + 9 - 6 - 13 + 6 \quad | \quad -23$$

x Multiply 1 by $-\frac{3}{1} \rightarrow -3$:

$$-3 - 3 + 6 - 3 - 9 + 3 \quad | \quad -12$$

Subtract from 5

$$-3 - 1 + 2 + 3 + 1 + 3 \quad | \quad 16$$

$$-3 - 3 + 6 - 3 - 9 + 3 \quad | \quad -12$$

$$0 + 2 - 4 + 6 + 10 + 0 \quad | \quad 28$$

x Multiply 1 by $\frac{4}{1} \rightarrow 4$ to have:

$$4 + 4 - 8 + 4 + 12 - 4 \quad | \quad 16$$

Subtract from 6

$$4 + 3 + 1 - 6 - 3 - 2 \quad | \quad -27$$

$$4 + 4 - 8 + 4 + 12 - 4 \quad | \quad 16$$

$$0 - 1 + 9 - 10 - 15 + 2 \quad | \quad -43$$

Therefore:

$$1 + 1 - 2 + 1 + 3 - 1 \quad | \quad 4$$

$$0 - 3 + 5 + 0 - 5 - 1 \quad | \quad 12$$

$$0 + 2 - 1 - 2 - 1 + 2 \quad | \quad -19$$

$$0 - 3 + 9 - 6 - 13 + 6 \quad | \quad -23$$

$$0 + 2 - 4 + 6 + 10 + 0 \quad | \quad 28$$

$$0 - 1 + 9 - 10 - 15 + 2 \quad | \quad -43$$

Multiply 2' through by $-\frac{2}{3}$ to have:

$$0 + 2 - \frac{10}{3} + 0 + \frac{10}{3} + \frac{2}{3} \quad | \quad -8$$

Subtract from 3'

$$0 + 2 - 1 - 2 - 1 + 2 \quad | \quad 19$$

$$0 + 2 - \frac{10}{3} + 0 + \frac{10}{3} + \frac{2}{3} \quad | \quad -8$$

$$0 + 0 + \frac{7}{3} - 2 - \frac{13}{3} + \frac{4}{3} \quad | \quad -11$$

Multiply 2' through by $-\frac{3}{3} \rightarrow 1$:

$$0 - 3 + 5 + 0 - 5 - 1 \quad | \quad 12$$

Subtract from 4'

$$0 \ 3 + 9 - 6 - 13 + 6 \quad | \quad -23$$

$$0 - 3 + 5 + 0 - 5 - 1 \quad | \quad 12$$

$$0 + 0 + 4 - 6 - 8 + 7 \quad | \quad -35$$

Multiply 2' through by $-2/3$:

$$0 + 2 - 10/3 + 0 + 10/3 + 2/3 \quad | \quad -8$$

Subtract from 5'

$$0 + 2 - 4 + 6 + 10 + 0 \quad | \quad 28$$

$$- 0 + 2 - 10/3 + 0 - 10/3 + 2/3 \quad | \quad -8$$

$$0 + 0 - 2/3 + 6 + 20/3 - 2/3 \quad | \quad 36$$

Multiply 2' through by $-1/3 \rightarrow 1/3$:

$$0 - 1 + 5/3 + 0 - 5/3 - 1/3 \quad | \quad 4$$

Subtract from 6'

$$0 - 1 + 9 - 10 - 15 + 2 \quad | \quad -43$$

$$- 0 - 1 + 5/3 + 0 - 5/3 - 1/3 \quad | \quad 4$$

$$0 + 0 + 22/3 - 10 - 40/3 + 7/3 \quad | \quad -47$$

Therefore:

$1 + 1 - 2 + 1 + 3 - 1$	4
$0 - 3 + 5 + 0 - 5 - 1$	12
$0 + 0 + 7/3 - 2 - 13/3 + 4/3$	-11
$0 + 0 + 4 - 6 - 8 + 7$	-35
$0 + 0 - 2/3 + 6 + 20/3 - 2/3$	36
$0 + 0 + 22/3 - 10 - 40/3 + 7/3$	-47

Multiply 3'' by $4 \times 3/7 \rightarrow 12/7$:

$$0 + 0 + 4 - 24/7 - 52/7 + 16/7 \quad | \quad -132/7$$

Subtract from 4''

$$0 + 0 + 4 - 6 - 8 + 7 \quad | \quad -35$$

$$- 0 + 0 + 4 - 24/7 - 52/7 + 16/7 \quad | \quad -132/7$$

$$0 + 0 + 0 - 18/7 - 4/7 + 33/7 \quad | \quad -113/7$$

Multiply 3'' by $-2/3 \times 3/7 \rightarrow -2/7$:

$$0 + 0 - 2/3 + 4/7 + 26/21 - 8/21 \quad | \quad 22/7$$

Subtract from 5''

$$0 + 0 - 2/3 + 6 + 20/3 - 2/3 \quad | \quad 36$$

$$- 0 + 0 - 2/3 + 4/7 + 26/21 - 8/21 \quad | \quad 22/7$$

$$0 + 0 + 0 + 38/7 + 38/7 - 2/7 \quad | \quad 230/7$$

Multiply 3" by $22/3 \times 3/7 \rightarrow 22/7$:

$$0 + 0 + 22/3 - 44/7 - 286/21 + 88/21 \quad | \quad -242/7$$

Subtract from 6"

$$0 + 0 + 22/3 - 10 - 40/3 + 7/3 \quad | \quad -47$$

$$0 + 0 + 22/3 - 44/7 - 286/21 + 88/21 \quad | \quad -242/7$$

$$0 + 0 + 0 - 26/7 + 2/7 - 13/7 \quad | \quad -87/7$$

Therefore:

$1 + 1 - 2 + 1 + 3 - 1$	4
$0 - 3 + 5 + 0 - 5 - 1$	12
$0 + 0 + 7/3 - 2 - 13/3 + 4/3$	-11
$0 + 0 + 0 - 18/7 - 4/7 + 33/7$	-113/7
$0 + 0 + 0 + 38/7 + 38/7 - 2/7$	230/7
$0 + 0 + 0 - 26/7 + 2/7 - 13/7$	-87/7

Multiply 4" by $38/7 \times -7/18 \rightarrow -19/9$:

$$0 + 0 + 0 + 38/7 + 76/63 - 209/21 \quad | \quad 2147/63$$

Subtract from 5"

$$0 + 0 + 0 + 38/7 + 38/7 - 2/7 \quad | \quad 230/7$$

$$0 + 0 + 0 + 38/7 + 76/63 - 209/21 \quad | \quad 2147/63$$

$$0 + 0 + 0 + 0 + 38/9 + 29/3 \quad | \quad -11/9$$

Multiply 4" by $-26/7 \times -7/18 \rightarrow 13/9$:

$$0 + 0 + 0 - 26/7 + 2/7 - 13/7 \quad | \quad -87/7$$

$$0 + 0 + 0 - 26/7 - 52/63 + 143/21 \quad | \quad -1469/63$$

$$0 + 0 + 0 + 0 + 10/9 - 26/3 \quad | \quad 98/9$$

Therefore:

$1 + 1 - 2 + 1 + 3 - 1$	4
$0 - 3 + 5 + 0 - 5 - 1$	12
$0 + 0 + \frac{7}{3} - 2 - \frac{13}{3} + \frac{4}{3}$	-11
$0 + 0 + 0 - \frac{18}{7} - \frac{4}{7} + \frac{53}{7}$	$-\frac{113}{7}$
$0 + 0 + 0 + 0 + \frac{38}{9} + \frac{29}{3}$	$-\frac{11}{9}$
$0 + 0 + 0 + 0 + \frac{10}{9} - \frac{26}{3}$	$\frac{98}{9}$

Multiply 5^{IV} by $\frac{10}{9} \times \frac{9}{38} \rightarrow \frac{5}{19}$

$$0 + 0 + 0 + 0 + \frac{10}{9} + \frac{145}{57} \quad | \quad -\frac{55}{171}$$

Subtract from b^{IV}

$$\begin{array}{r|l} 0 + 0 + 0 + 0 + \frac{10}{9} - \frac{26}{3} & \frac{98}{9} \\ - 0 + 0 + 0 + 0 + \frac{10}{9} + \frac{145}{57} & -\frac{55}{171} \\ \hline 0 + 0 + 0 + 0 + 0 - \frac{213}{19} & \frac{213}{19} \end{array}$$

Therefore:

$1 + 1 - 2 + 1 + 3 - 1$	4
$0 - 3 + 5 + 0 - 5 - 1$	12
$0 + 0 + \frac{7}{3} - 2 - \frac{13}{3} + \frac{4}{3}$	-11
$0 + 0 + 0 - \frac{18}{7} - \frac{4}{7} + \frac{53}{7}$	$-\frac{113}{7}$
$0 + 0 + 0 + 0 + \frac{38}{9} + \frac{29}{3}$	$-\frac{11}{9}$
$0 + 0 + 0 + 0 + 0 - \frac{213}{19}$	$\frac{213}{19}$

For Back Substitution:

$$-\frac{213}{19} T_6 = \frac{213}{19}$$

$$T_6 = -1$$

$$T_5 \frac{38}{9} + T_6 \frac{29}{3} = -11$$

$$T_5 \frac{38}{9} + (-1) \frac{29}{3} = -11 \rightarrow T_5 \frac{38}{9} = -11 + \frac{29}{3}$$

$$\frac{38}{9} T_5 = \frac{76}{9}$$

$$T_5 = 2$$

$$\frac{-18T_4}{7} - \frac{4}{7}T_5 + \frac{33}{7}T_6 = -113$$

$$\frac{-18T_4}{7} - \frac{8}{7} - \frac{33}{7} = -113$$

$$\frac{-18T_4}{7} = -113 + \frac{8}{7} + \frac{33}{7}$$

$$\frac{-18T_4}{7} = -72$$

$$T_4 = 4$$

$$\frac{7}{3}T_3 - 2T_4 - \frac{13}{3}T_5 + \frac{4}{3}T_6 = -11$$

$$\frac{7}{3}T_3 - 8 - \frac{26}{3} - \frac{4}{3} = -11$$

$$\frac{7}{3}T_3 = -11 + 8 + \frac{26}{3} + \frac{4}{3}$$

$$\frac{7}{3}T_3 = 7$$

$$T_3 = 3$$

$$-3T_2 + 5T_3 + 0 - 5T_4 - T_6 = 12$$

$$-3T_2 + 15 + 0 - 10 + 1 = 12$$

$$-3T_2 = 12 - 15 + 10 - 1$$

$$-3T_2 = 6$$

$$T_2 = -2$$

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

$$T_1 - 2 - 6 + 4 + 6 + 1 = 4$$

$$T_1 = 4 + 2 + 6 - 4 - 6 + 1$$

$$T_1 = 1$$

$$\therefore T_1 = 1$$

$$T_2 = -2$$

$$T_3 = 3$$

$$T_4 = 4$$

$$T_5 = 2$$

$$T_6 = -1$$