LAB #5
USING MATLAB AND SOLVING SYSTEMS OF EQUATIONS

Austin Guerrero
ECE 263 Linear Circuit Theory I | Fall 2026 | October 5, 2026
Department of Electrical and Computer Engineering
Valparaiso University

ABSTRACT

In this lab, MATLAB was used as a calculator, a matrix tool, a plotting tool, and a circuit solver. Every prediction for Problems 1.1 and 1.2 matched MATLAB, and Problem 2.1 found three cylinder volumes with one line of code. A 60 Hz sine and cosine with a $-\pi/4$ phase were plotted on one figure. Nodal analysis of the worksheet circuit was solved with *rref*, giving $i_5 = 1.352$ A, and a 3×3 system was solved on a calculator, giving $\mathbf{x} = [2, -1, 3]$.

♦ INTRODUCTION

The goal of this lab is to learn the MATLAB basics needed for circuit analysis. Solving a circuit with several unknown node voltages by hand takes a lot of algebra, and every step is a chance to drop a sign. MATLAB turns that work into one matrix and one command [4]. The lab moved from simple calculations and matrices to a plot of two sinusoids, a nodal analysis problem, and a matrix equation solved on a handheld calculator.

♦ THEORY

Order of Operations

MATLAB evaluates parentheses first, then exponents, then multiplication and division, and then addition and subtraction, working left to right at each level. This is why `1+3+5/5+3+1` returns 9 while `(1+3+5)/(5+3+1)` returns 1.

Nodal Analysis

The circuit is shown on the lab worksheet (Fig. 5), and its node labels are marked in the hand work (Fig. 17). Using the bottom node as the reference and summing the currents leaving each node gives

$$\frac{V_0}{5} + \frac{V_0 - V_1}{3} + \frac{V_0 - V_2}{7} = 3 \tag{1}$$

$$\frac{V_1 - V_0}{3} + \frac{V_1 - V_2}{4} + \frac{V_1 - V_4}{1} = 2 \tag{2}$$

$$\frac{V_2 - V_0}{7} + \frac{V_2 - V_1}{4} + \frac{V_2}{6} = 0 \tag{3}$$

$$\frac{V_4 - V_1}{1} + \frac{V_4}{2} = -3 \tag{4}$$

The current through the 5 Ω resistor is

$$i_5 = \frac{V_0}{5} \tag{5}$$

so i_5 was kept as a fifth unknown, replacing $V_0/5$ in (1).

Solving Systems of Equations

A set of linear equations can be written as

$$\mathbf{Ax} = \mathbf{b} \;\Rightarrow\; \mathbf{x} = \mathbf{A}^{-1}\mathbf{b} \tag{6}$$

MATLAB can solve this with `inv(A)*b` or `A\b`, or by reducing the augmented matrix `[A b]` with *rref*, which leaves the solution in the last column.

Sinusoids

A sinusoid with frequency f and phase φ is

$$y(t) = \sin(2\pi f t + \phi) \tag{7}$$

At 60 Hz, the period is about 16.67 ms. A cosine leads a sine by 90°, or a quarter period.

♦ PROCEDURE

The procedure followed the Lab 5 worksheet [1]. The Command Window was cleared with `clc` before each printed portion.

I. The Calculator handout was completed, and Problems 1.1 and 1.2 were predicted by hand and checked in MATLAB.
II. The Creating Matrices handout was completed, and Problem 2.1 was solved with a script.
III. The Formatting Numbers, Saving Your Work, and Matrix Multiplication handouts were completed and printed.

IV. A script, `tutorial8.m`, was written to plot the sine and cosine, and the figure was saved as a JPEG.

V. Equations (1) through (5) were put into matrix form and solved in MATLAB with *rref*.

VI. The system in (9) was solved on a handheld calculator for sign-off.

♦ RESULTS

Table 1 shows how values display under the formats tested, and Table 2 lists the matrix multiplication results. All printouts are in the Appendix.

Table 1: Display Formats Tested in MATLAB

Format	Command Entered	Displayed Result
short	`y = 5.1`	5.1000
long	`y = 5.1`	5.100000000000000
bank	`f = 2/3`	0.67
long g	`volume`	388.235700000004
short e	`a = 4.1`	4.1000e+00
rat	`t = 6/25`	6/25

Table 2: Matrix Multiplication Results

MATLAB Expression	Result
`5*[3 4; 2 -1]`	[15 20; 10 −5]
`[1 2 3; 4 5 6]*[7 8 9 10; 13 18 11 14; 12 16 17 15]`	[69 92 82 83; 165 218 193 200]
`[79 119 199]*[72 78 85 80; 40 31 30 18; 12 14 23 32]`	[12836 12637 14862 14830]
`([5 2; 4 2]^-1)*[17; 22]`	[−5; 21]
`([5 2; 4 3]^-1)*[17; 22]`	[1; 6]

In matrix form, (1) through (5) become

$$\begin{bmatrix} 1 & \frac{1}{7}+\frac{1}{3} & -\frac{1}{3} & -\frac{1}{7} & 0 \\ 0 & -\frac{1}{7} & -\frac{1}{4} & \frac{1}{4}+\frac{1}{7}+\frac{1}{6} & 0 \\ 0 & -\frac{1}{3} & \frac{1}{4}+\frac{1}{3}+\frac{1}{1} & -\frac{1}{4} & -1 \\ 0 & 0 & -1 & 0 & \frac{1}{1}+\frac{1}{2} \\ 1 & -\frac{1}{5} & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} i_5 \\ V_0 \\ V_1 \\ V_2 \\ V_4 \end{bmatrix} = \begin{bmatrix} 3 \\ 0 \\ 2 \\ -3 \\ 0 \end{bmatrix} \tag{8}$$

and the solution is listed in Table 3. The first MATLAB run (Fig. 16) had −1/3 in the last row; Table 3 uses the corrected value of −1/5.

Table 3: Node Voltages and i_5

i_5 (A)	V_0 (V)	V_1 (V)	V_2 (V)	V_4 (V)
1.3521	6.7604	3.3355	3.2164	0.2237

The calculator system from the worksheet was

$$\begin{bmatrix} 2 & -1 & 3 \\ 1 & 4 & -2 \\ -3 & 2 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 14 \\ -8 \\ -5 \end{bmatrix} \tag{9}$$

and the calculator returned $x_1 = 2$, $x_2 = -1$, and $x_3 = 3$.

♦ QUESTIONS FROM LAB HANDOUT

1. Problem 1.1: All seven predictions matched MATLAB (Fig. 6).

Table 4: Problem 1.1 Predictions

Part	Expression	Predicted	MATLAB
a	`1+3/4`	1.75	1.7500
b	`5*6*4/2`	60	60
c	`5/2*6*4`	60	60
d	`5^2*3`	75	75
e	`5^(2*3)`	15625	15625
f	`1+3+5/5+3+1`	9	9
g	`(1+3+5)/(5+3+1)`	1	1

2. Problem 1.2: Each calculation was coded in a script (Fig. 7).

Table 5: Problem 1.2 Code and Results

Part	MATLAB Code	Result
a	`a = 5^2`	25
b	`b = (5+3)/(5*6)`	0.2667
c	`c = sqrt(4+6^3)`	14.8324
d	`d = 9*(6/12)+7*5^(3+2)`	21879.5
e	`e = 1+5*3/(6^2)+(2^(2-4))*1/5.5`	1.4621

3. Problem 2.1: With r = 3 and h = [2, 4, 6], `cyl = pi*r^2*h` returns all three volumes at once (Figs. 7 and 8).

Table 6: Problem 2.1 Cylinder Volumes

Height, h	Volume, $\pi r^2 h$
2	56.5487
4	113.0973
6	169.6460

♦ CONCLUSION

MATLAB handled every part of this lab, from basic arithmetic to a five-unknown circuit. The main lesson is that MATLAB does exactly what is typed, so a missing parenthesis or a wrong entry gives a wrong answer without any warning. Checking results against a hand prediction or KCL caught those mistakes, and the final answer for the circuit was $i_5 = 1.352$ A.

♦ ACKNOWLEDGEMENTS

The Objectives, Procedure, and handout problems were paraphrased from the ECE 263 Lab 5 worksheet [2], which is included as Figs. 3 through 8.

♦ REFERENCES

[1] “Laboratory #5: Using MATLAB and Solving Systems of Equations,” ECE 263L Linear Circuit Theory I Laboratory, Dept. of Electrical and Computer Engineering, Valparaiso University, Fall 2026.

APPENDIX

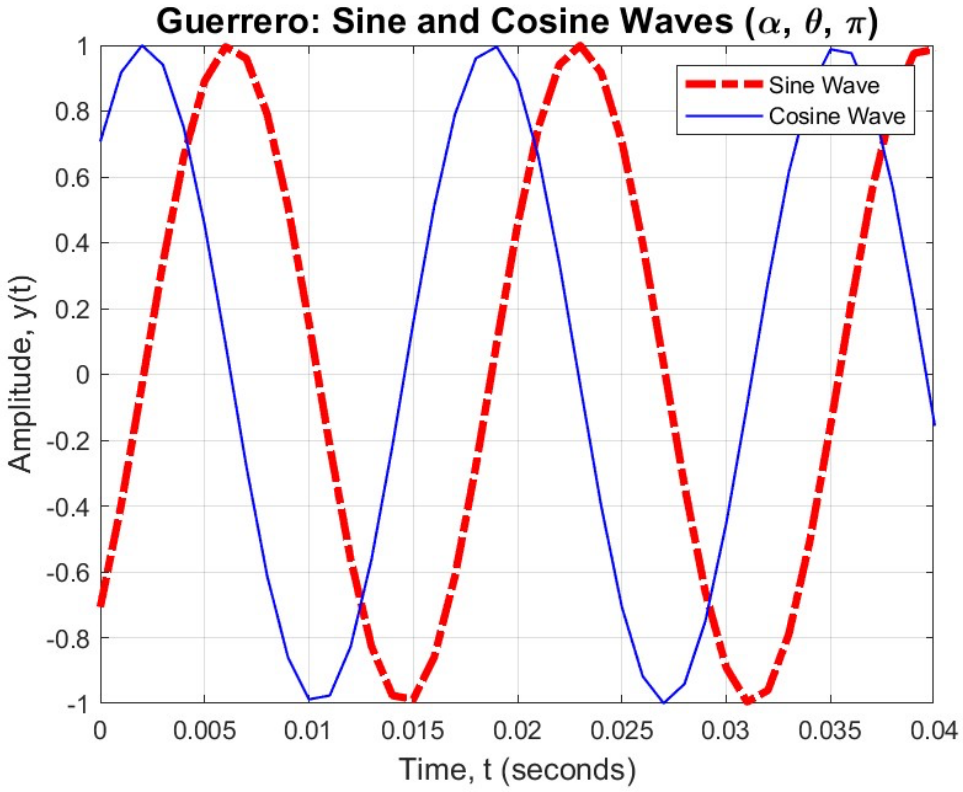


Fig 1. ***Sine and cosine at 60 Hz with −π/4 phase (Guerrero_Sine_Cosine.jpg)***

APPENDIX

```
t = 0:0.001:0.04;

f = 60;
phase = -pi/4;

y_sin = sin(2*pi*f*t + phase);
y_cos = cos(2*pi*f*t + phase);

figure;

plot(t, y_sin, 'r-.', 'LineWidth', 3);

hold on;

plot(t, y_cos, 'b-', 'LineWidth', 1);

grid on;

title('Guerrero: Sine and Cosine Waves (\alpha, \theta, \pi)', ...
      'FontSize', 14);

xlabel('Time, t (seconds)', 'FontSize', 12);
ylabel('Amplitude, y(t)', 'FontSize', 12);

legend('Sine Wave', 'Cosine Wave');

saveas(gcf, 'Guerrero_Sine_Cosine.jpg');
```

Fig 2. ***Script file tutorial8.m used to generate Fig. 1***

APPENDIX

ECE 263L / Linear Circuit Theory I Laboratory #5 Name: Austin Guerrero

Using MATLAB and Solving Systems of Equations

Honor
Code

"I have neither given or received, nor tolerated others use of unauthorized aid."

Austin Guerrero
Signature

Objectives:

The objectives for this laboratory assignment are shown below.

1. ***Use*** MATLAB as a calculator.
2. ***Use*** MATLAB to create matrices.
3. ***Use*** MATLAB to format numbers.
4. ***Use*** MATLAB to save your work.
5. ***Use*** MATLAB to solve systems of equations.
6. ***Use*** MATLAB *to plot nifty figures!!!*
7. ***Use*** MATLAB to solve for node voltages using nodal analysis.
8. ***Solve*** a Matrix equation using your calculator

1. Using MATLAB as a Calculator

   A. Work your way through the Using MATLAB as a Calculator handout.
   B. Clear the Command Window. (clc)
   C. Complete Problems 1.1 and 1.2 at the end of this handout.
   D. Print (or copy and paste into a document) your Command Window showing your work for Problems 1.1 and 1.2. Please circle your answers to each problem and staple them to this sheet.

2. Creating Matrices with MATLAB

   A. Work your way through the Creating Matrices with MATLAB handout.
   B. Clear the Command Window. (clc)
   C. Complete Problem 2.1 at the end of this handout with matrices.
   D. Print (or copy and paste into a document) your Command Window showing your work for Problem 2.1.
   Please circle your answer and staple it to this sheet.

Fig 3. ***Completed Lab 5 worksheet (page 1 of 6)***

APPENDIX

3. Formatting Numbers in MATLAB
   A. You will be printing your results of this handout directly, so make sure you perform each step in the handout,
   B. Clear the Command Window. (clc)
   C. Work your way through the Formatting Numbers in MATLAB handout.
   D. Print out (or copy and paste into a document) your Command Window showing you performed each step in the handout and staple them to this sheet.

4. Saving Your Work in MATLAB
   A. Work your way through the Saving Your Work in MATLAB handout.

5. Solving Systems of Equations in MATLAB with Matrix Multiplication
   A. You will be printing your results of this handout directly, so make sure you perform each step in the handout,
   B. Clear the Command Window.
   C. Work your way through three handouts on Matrices, Matrices in MATLAB, and Matrix Multiplication.
   D. Print out (or copy and paste into a document) your Command Window showing you performed each step in the handout and staple them to this sheet.

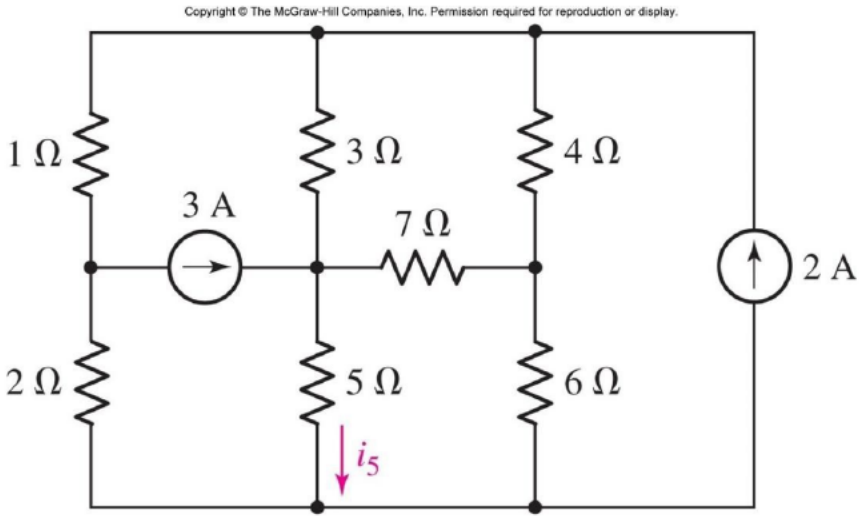
6. ***Use*** MATLAB *to plot nifty figures!!!*
   A. Work your way through the handouts on plotting figures.
   B. Create a figure with the following requirements:
      1. Create a script file for all the commands to generate the figure/
      2. Create a time variable between 0 and 0.4 s with a step size of 0.001.
      3. Create a **cosine** with a frequency of 60 Hz and phase of $-\pi/4$ radians.
      4. Create a **sine** with a frequency of 60 Hz and phase of $-\pi/4$ radians.
      5. Plot the **sine** on a figure in a **red, dash-dotted line with a linewidth of 3.**
      6. Plot the **cosine** on the SAME figure in a **blue, solid line with a linewidth of 1.**
         Hint: See the **hold on** command.
      7. Label the x and y axes
      8. In the title, put **your name and at least 3 Greek Characters.**
   C. Under the file menu on the figure, save your figure as a JPEG image.
      Include your last name in the file name.
   D. Print out (or copy and paste) your script file into your report.

Fig 4. ***Completed Lab 5 worksheet (page 2 of 6)***

APPENDIX

7. Use nodal analysis to analyze the circuit below and determine the current i_5.

   A. Clear the Command Window and create an m-file for your work
   B. Use MATLAB to solve the final matrix equation to determine the node voltages.
   C. Print out your m-file showing your work.
   D. On the circuit below out, clearly show your node voltages and how you calculate i_5 from these results and scan this work and include it in your submission.



.

8. Every calculator will be a little different but in general the following steps are required
   A. Place your calculator in Matrix Mode
   B. Enter in the Matrix (A) part of your equation
   C. Enter in the solution vector (b)
   D. Tell the calculator to find

   Solve the following matrix equation **<u>on your calculator</u>** and demonstrate it to the professor or a TA.

$$\begin{bmatrix} 2 & -1 & 3 \\ 1 & 4 & -2 \\ -3 & 2 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 14 \\ -8 \\ -5 \end{bmatrix}$$

   We will keep a sign-off sheet of our own in the lab.

Fig 5. ***Completed Lab 5 worksheet (page 3 of 6)***

APPENDIX

Appendix: Questions:

Problem 1.1:

Predict the outcome of the following MATLAB calculations.

(a) 1+3/4 =**1.75**

(b) 5*6*4/2=**60**

(c) 5/2*6*4=**60**

(d) 5^2×3=**75**

(e) 5^(2*3)=**15625**

(f) 1+3+5/5+3+1=**9**

(g) (1+3+5)/(5+3+1)=**1**

Check your predictions by entering the calculations into a command window.

```
>> 1+3/4
5*6*4/2
5/2*6*4
5^2*3
5^(2*3)
1+3+5/5+3+1
(1+3+5)/(5+3+1)

ans =

    1.7500


ans =

    60


ans =

    60


ans =

    75


ans =

       15625


ans =

     9


ans =

     1
```

Fig 6. ***Completed Lab 5 worksheet (page 4 of 6)***

APPENDIX

Problem 1.2:

Create MATLAB code to perform the following calculations:

(a) $5^2 = \mathbf{25}$

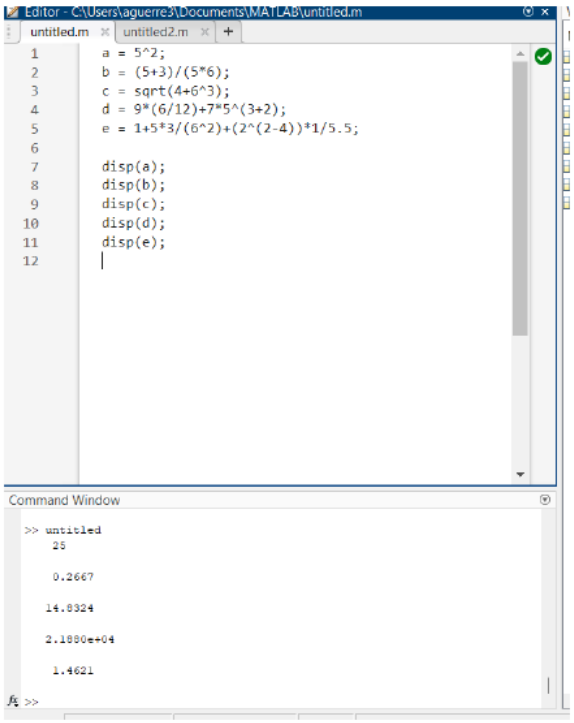
(b) $(5 + 3)/(5 \cdot 6) = \mathbf{.26667}$

(c) $\sqrt{(4 + 6^3)} = \mathbf{14.832397}$

(d) $9(6/12) + 7 \cdot 5^{3+2} = \mathbf{43759/2}$

(e) $1 + 5 \cdot 3/6^2 + 2^{2-4} \cdot 1/5.5 = \mathbf{1.4621212}$

Check your predictions by entering the calculations into a command window.



Problem 2.1:

The volume of a cylinder is $\pi r^2 h$ where r is the radius of the cylinder and h is the height.

Use MATLAB to calculate the volume of three cylinders with r=3 and the height given by the vector

h = [2, 4, 6]

Fig 7. ***Completed Lab 5 worksheet (page 5 of 6)***

APPENDIX

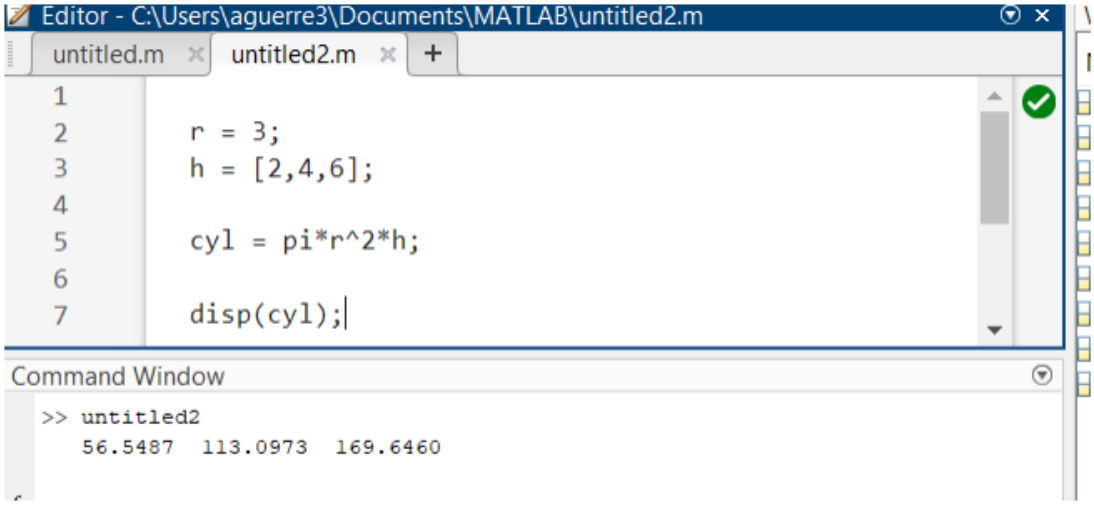


Fig 8. ***Completed Lab 5 worksheet (page 6 of 6)***

APPENDIX


```
>> format loose
>>
>> a = 3+2+1

a =

     6

>> format compact
>> b=3+2+1
b =
     6
>> z=-4;
>> c=1+2+3;
>> d=2*c-1;
>> e=c+d
e =
    17
>> format short
>> y=5.1
y =
    5.1000
>> z=5
z =
     5
>> format long
>> y=5.1
y =
   5.100000000000000
>> z=5
z =
     5
>> format short
>> m=1/3
m =
    0.3333
>> n=n/3
Unrecognized function or variable 'n'.
>> n=2/3
n =
    0.6667
>> format long
>> n=1/3
n =
   0.333333333333333
>> n=2.3
n =
   2.300000000000000
>> n=2/3
n =
   0.666666666666667
```

Fig 9. ***Formatting Numbers in MATLAB, Command Window (page 1 of 2)***

APPENDIX


```
>> format bank
>> f=2/3
f =
          0.67
>> g=5
g =
          5.00
>> volume = 3.88235700000004e+02
volume =
        388.24
>> format long g
>> volume
volume =
          388.235700000004
>> pe1E-6*[3 4.5 322]
Unrecognized function or variable 'pe1E'.
>> p = E-6*[3 4.5 22]
Unrecognized function or variable 'E'.
Did you mean:
>> p = e-6*[3 4.5 22]
p =
    -1   -10  -115
>> format long
>> p
p =
    -1   -10  -115
>> p = 1E-6*[3 4.5 22]
p =
   1.0e-04 *
   0.030000000000000   0.045000000000000   0.220000000000000
>> format short e
>> a = 4.1
a =
   4.1000e+00
>> format rat
>> t=6/25
t =
       6/25
>>
```

Fig 10. ***Formatting Numbers in MATLAB, Command Window (page 2 of 2)***

APPENDIX

```
MATLAB Command Window                                          Page 1

>> format short
>> time = [0 1 2 3 4 5]
time =
     0     1     2     3     4     5
>> height = [0 1 3 6 10 15]
height =
     0     1     3     6    10    15
>> plot(time, height)
>> time = [1;2;3;4;5]
time =
     1
     2
     3
     4
     5
>> time=[0;1;2;3;4;5]
time =
     0
     1
     2
     3
     4
     5
>> height=[0;1;3;6;10;15]
height =
     0
     1
     3
     6
    10
    15
>> deposits = [1 5 3; 2 6 8; 4 4 9]
deposits =
     1     5     3
     2     6     8
     4     4     9
>> deposits= [1 5 3;
2 6 8;
4 4 9;
}
 }
 ↑
Invalid expression. When calling a function or indexing a variable, use
parentheses. Otherwise, check for mismatched delimiters.

>> ]
 ]
 ↑
Invalid expression. When calling a function or indexing a variable, use
parentheses. Otherwise, check for mismatched delimiters.
```

Fig 11. ***Creating Matrices with MATLAB, Command Window (page 1 of 3)***

APPENDIX

MATLAB Command Window Page 2

```
>> deposits= [ 1 5 3 ;
2 6 8;
4 4 9;
]
deposits =
     1     5     3
     2     6     8
     4     4     9
>> x= [1:5]
x =
     1     2     3     4     5
>> y = [0 1 2 3:7]
y =
     0     1     2     3     4     5     6     7
>> z = [1:2:5]
z =
     1     3     5
>> q = [1:3:10]
q =
     1     4     7    10
>> t = [5:-1:0]
t =
     5     4     3     2     1     0
>> q = [0: pi/2: 2*pi]
q =
         0    1.5708    3.1416    4.7124    6.2832
>> time_length = [0:4;
0:pi/4:pi]
time_length =
         0    1.0000    2.0000    3.0000    4.0000
         0    0.7854    1.5708    2.3562    3.1416
>> linespace(1,21,3)
Unrecognized function or variable 'linespace'.
Did you mean:
>> linspace(1 , 21 , 3)
ans =
     1    11    21
>> logspace(0,2,3)
ans =
     1    10   100
>> b = [20 15 10 5]
b =
    20    15    10     5
>> c = [20:-5:5]
c =
    20    15    10     5
>> d = linespace(20,5,4)
Unrecognized function or variable 'linespace'.
Did you mean:
>> d = linespace(20,5,4)
Unrecognized function or variable 'linespace'.
```

Fig 12. ***Creating Matrices with MATLAB, Command Window (page 2 of 3)***

APPENDIX

```
MATLAB Command Window                                                Page 3

Did you mean:
>> d = linspace(20,5,4)
d =
    20    15    10     5
>> m = [0 5 10 15 ; 20 25 30 35]
m =
     0     5    10    15
    20    25    30    35
>> n = [0:5:15;20:5:35]
n =
     0     5    10    15
    20    25    30    35
>> p = [0 5 10 15;20 25 30 35;
]
p =
     0     5    10    15
    20    25    30    35
>> time = [0;3;5;9]
time =
     0
     3
     5
     9
>>
```

Fig 13. ***Creating Matrices with MATLAB, Command Window (page 3 of 3)***

```
MATLAB Command Window                                                Page 1

>> 5 * [3 4;2 -1]
ans =
    15    20
    10    -5
>> [1 2 3; 4 5 6][7 8 9 10; 13 18 11 14; 12 16 17 15]
 [1 2 3; 4 5 6][7 8 9 10; 13 18 11 14; 12 16 17 15]
                ↑
Invalid expression. When calling a function or indexing a variable, use
parentheses. Otherwise, check for mismatched delimiters.

>> [1 2 3; 4 5 6]*[7 8 9 10; 13 18 11 14; 12 16 17 15]
ans =
    69    92    82    83
   165   218   193   200
>> [79 119 199]*[72 78 85 80; 40 31 30 18; 12 14 23 32]
ans =
       12836       12637       14862       14830
>> ([5 2; 4 2]^-1)*[17; 22]
ans =
    -5
    21
>> ([5 2; 4 3]^-1)*[17; 22]
ans =
     1
     6
>>
```

Fig 14. ***Matrix Multiplication, Command Window***

APPENDIX

```
MATLAB Command Window                                                Page 1

>> b = [3 4]
b =
     3     4
>> a = [2 3 b 5]
a =
     2     3     3     4     5
>> c = [a;b 207 b]
c =
     2     3     3     4     5
     3     4   207     3     4
>> e = [54 68 49]
e =
    54    68    49
>> f = e(1)
f =
    54
>> k = [1:10]
k =
     1     2     3     4     5     6     7     8     9    10
>> p = k'
p =
     1
     2
     3
     4
     5
     6
     7
     8
     9
    10
>> r = [4 7 2; 3 9 -1; 0 2 4]
r =
     4     7     2
     3     9    -1
     0     2     4
>> s = r'
s =
     4     3     0
     7     9     2
     2    -1     4
>> w = [4 -2 13 19; 0 22 16 -1; 4 3 2 1]
w =
     4    -2    13    19
     0    22    16    -1
     4     3     2     1
>> a w(:,1)
Unrecognized function or variable 'a'.
>> a = w(:,1)
a =
     4
```

```
MATLAB Command Window                                                Page 2

     0
     4
>> w
w =
     4    -2    13    19
     0    22    16    -1
     4     3     2     1
>>
```

Fig 15. ***Matrices in MATLAB, Command Window***

APPENDIX

```
MATLAB Command Window                                                Page 1

>> is= [1 1/7+1/3 -1/3 -1/7 0 3; 0 -1/7 -1/4 1/4+1/7+1/6 0 0; 0 -1/3 1/4+1/3+1/1 -1/4 -1↙
2; 0 0 -1 0 1/1+1/2 -3; 1 -1/3 0 0 0 0]
is =
    1.0000    0.4762   -0.3333   -0.1429         0    3.0000
         0   -0.1429   -0.2500    0.5595         0         0
         0   -0.3333    1.5833   -0.2500   -1.0000    2.0000
         0         0   -1.0000         0    1.5000   -3.0000
    1.0000   -0.3333         0         0         0         0
>> rref is
Error using norm
First argument must be single or double.
Error in rat (line 57)
    tol = 1.e-6*norm(X(isfinite(X)),1);
                 ^^^^^^^^^^^^^^^^^^^^^
Error in rref (line 26)
[num, den] = rat(A);
             ^^^^^^
>> rref(is)
ans =
    1.0000         0         0         0         0    1.7328
         0    1.0000         0         0         0    5.1985
         0         0    1.0000         0         0    2.5649
         0         0         0    1.0000         0    2.4733
         0         0         0         0    1.0000   -0.2901
>> format short
>> rref(is)
ans =
    1.0000         0         0         0         0    1.7328
         0    1.0000         0         0         0    5.1985
         0         0    1.0000         0         0    2.5649
         0         0         0    1.0000         0    2.4733
         0         0         0         0    1.0000   -0.2901
>> format short g
>> rref(is)
ans =
            1            0            0            0            0       1.7328
            0            1            0            0            0       5.1985
            0            0            1            0            0       2.5649
            0            0            0            1            0       2.4733
            0            0            0            0            1     -0.29008
>>
```

Fig 16. ***Nodal analysis, Command Window (first run, row 5 entered as −1/3)***

APPENDIX

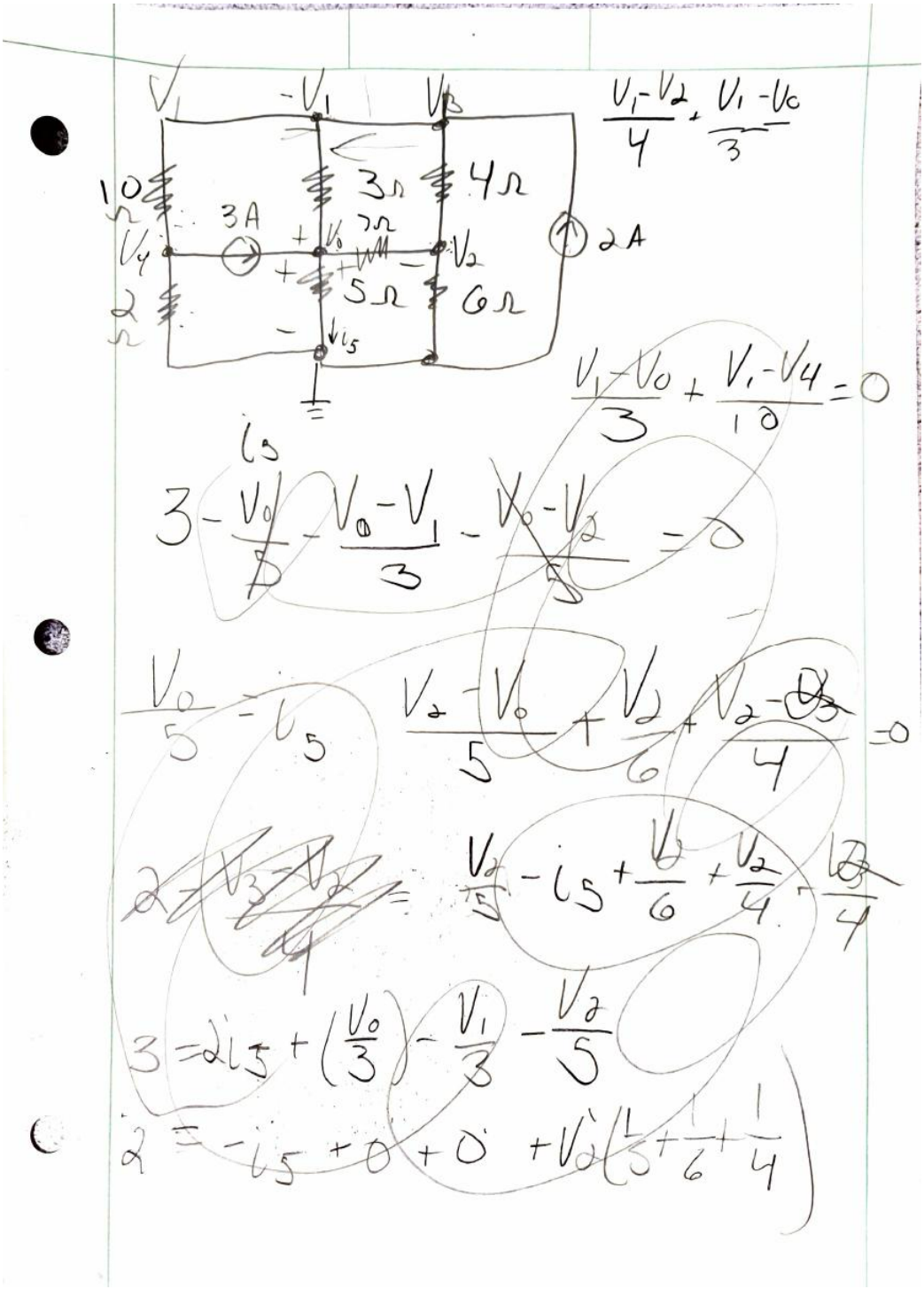


Fig 17. ***Hand work for the nodal analysis (page 1 of 4)***

APPENDIX

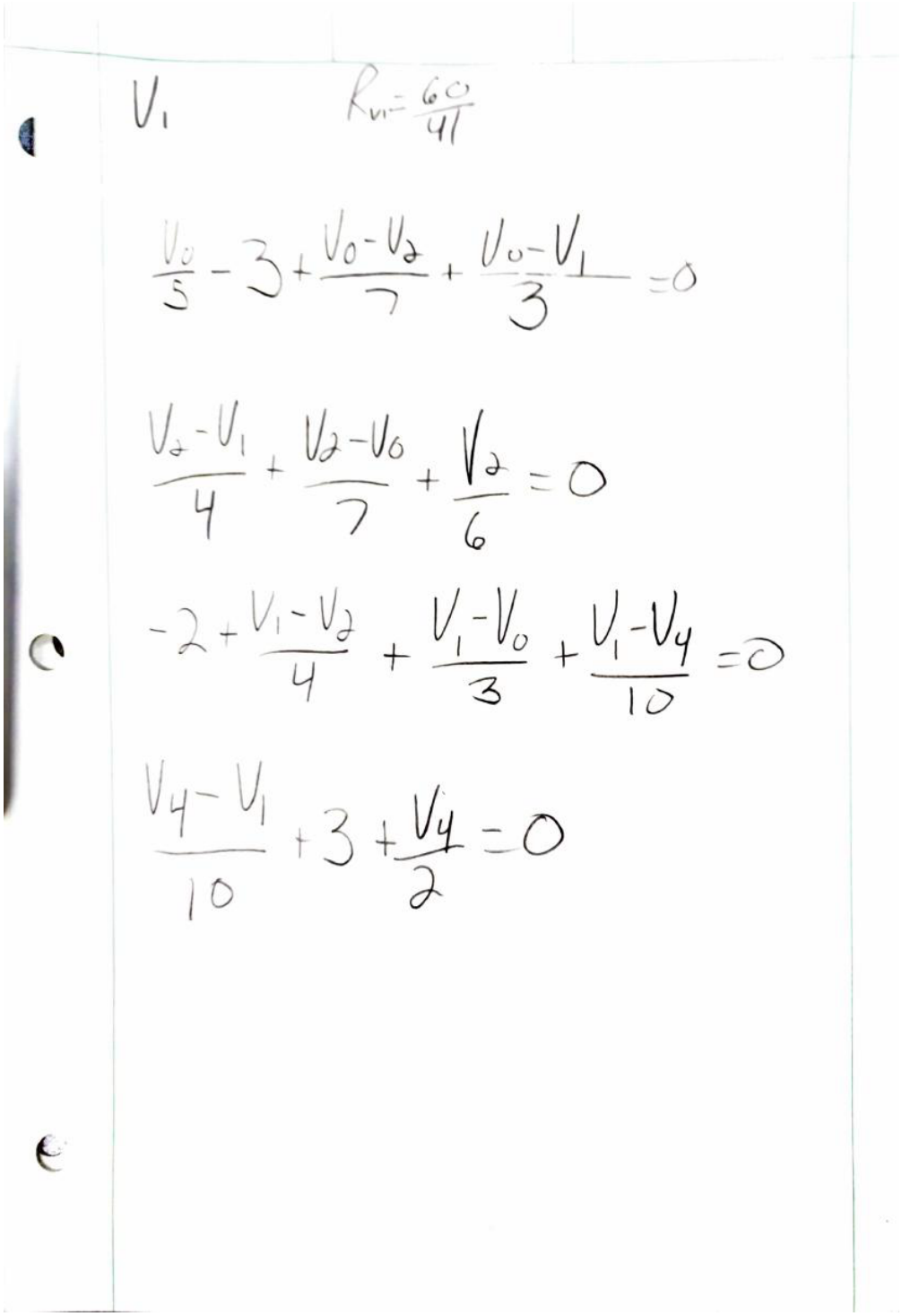


Fig 18. ***Hand work for the nodal analysis (page 2 of 4)***

APPENDIX

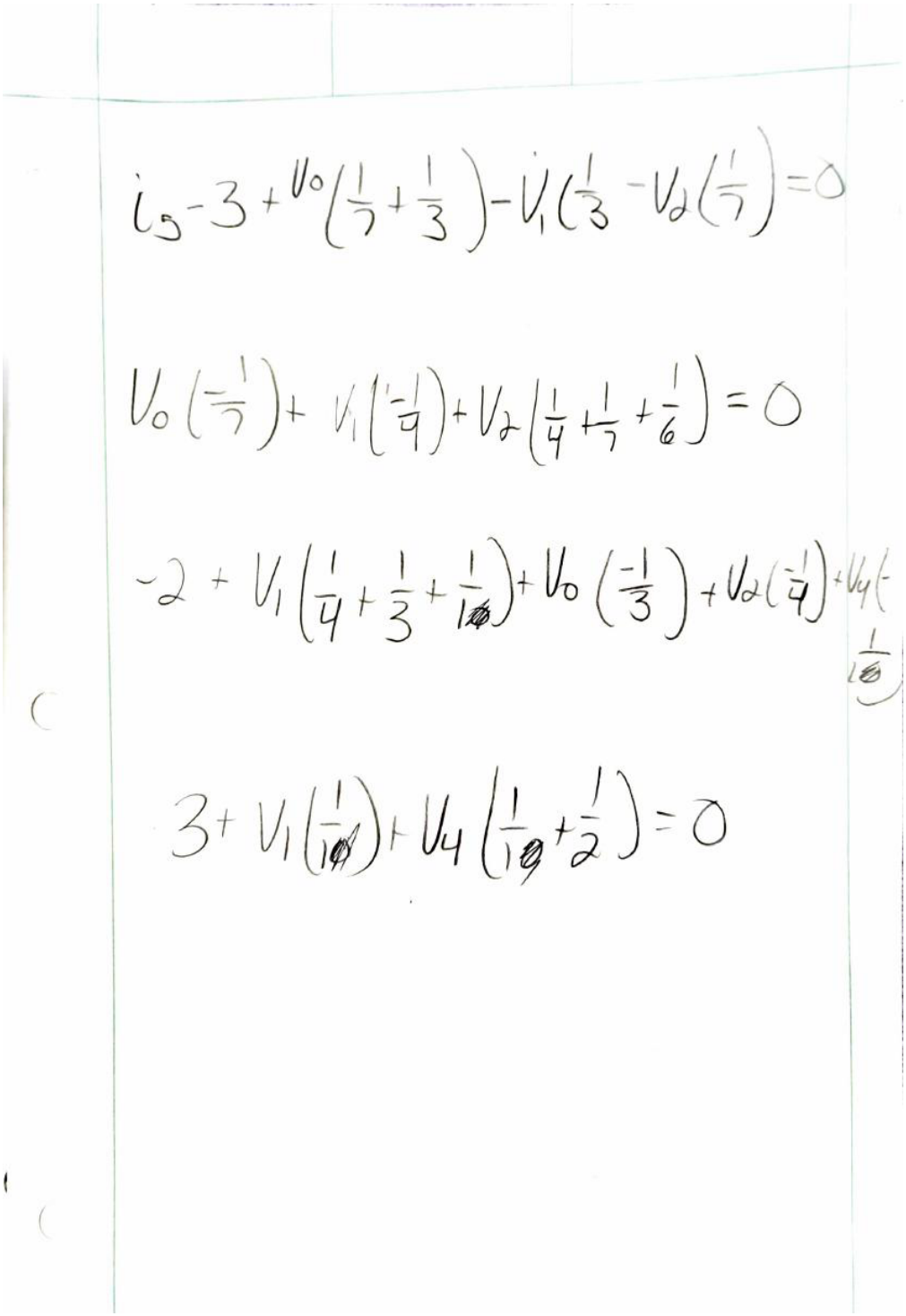


Fig 19. ***Hand work for the nodal analysis (page 3 of 4)***

APPENDIX

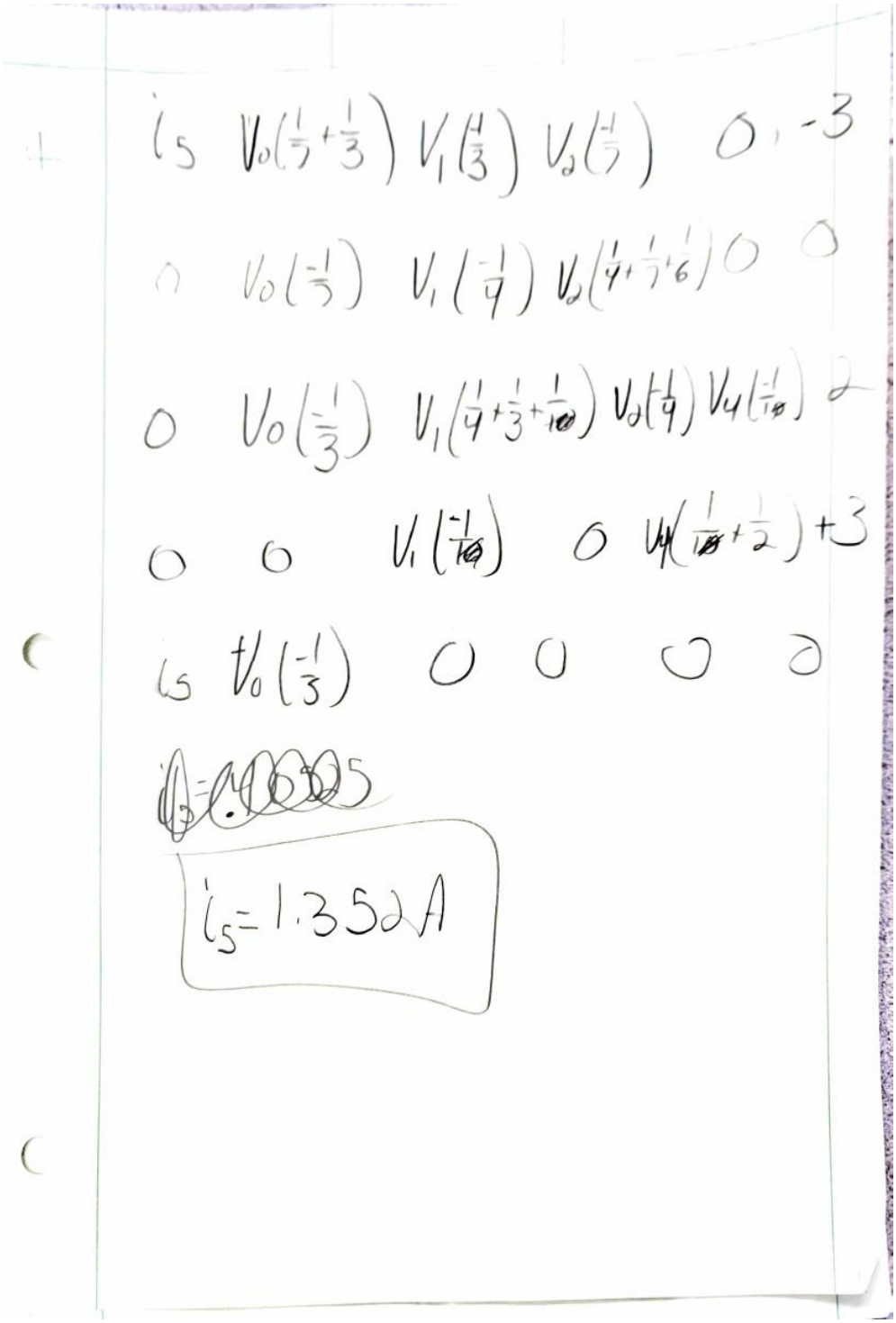


Fig 20. ***Hand work for the nodal analysis, final answer (page 4 of 4)***