MATH 152 MATLAB Computer Lab 4

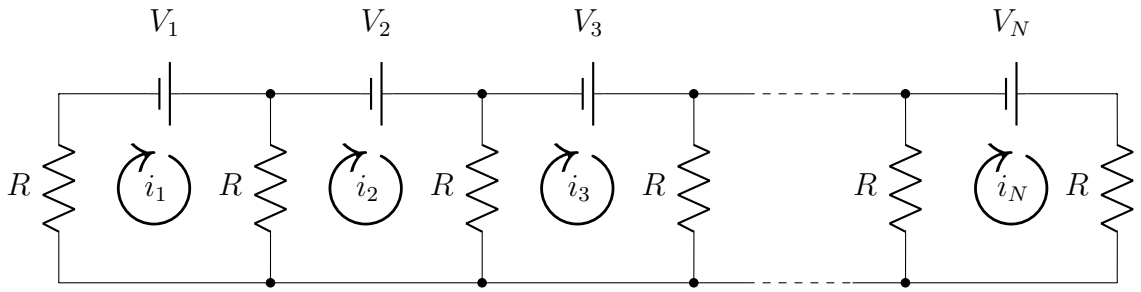
MATLAB Scripts and Resistor Networks

Instructions

- Save your work in a script to easily edit and rerun your results
- Make sure to save the variable for each exercise with the correct variable name
- Save all variables to a file called `lab4.mat` and submit the file to Canvas
- Attend your scheduled lab section and visit MATLAB TA office hours for extra help

Parallel Circuit

Each exercise below investigates the following parallel circuit with loop currents $i_1, \ldots, i_N$, voltage sources $V_1, \ldots, V_N$ and $N+1$ identical resistors R



The loop current equations yield the augmented matrix

$$\left[\begin{array}{cccccccc|c} 2R & -R & 0 & 0 & \cdots & 0 & 0 & 0 & V_1 \\ -R & 2R & -R & 0 & \cdots & 0 & 0 & 0 & V_2 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & \cdots & -R & 2R & -R & V_{N-1} \\ 0 & 0 & 0 & 0 & \cdots & 0 & -R & 2R & V_N \end{array}\right]$$

In matrix notation, the linear system is $A\mathbf{x} = \mathbf{b}$ where the coefficient matrix A is

$$A = \begin{bmatrix} 2R & -R & & & \\ -R & 2R & -R & & \\ & \ddots & \ddots & \ddots & \\ & & -R & 2R & -R \\ & & & -R & 2R \end{bmatrix}$$

In other words, A is the $N \times N$ matrix with $2R$ in the diagonal entries, $-R$ in the entries above and below the main diagonal, and zeros everywhere else. The vectors $\mathbf{x}$ and $\mathbf{b}$ are

$$\mathbf{x} = \begin{bmatrix} i_1 \\ \vdots \\ i_N \end{bmatrix} \qquad \mathbf{b} = \begin{bmatrix} V_1 \\ \vdots \\ V_N \end{bmatrix}$$

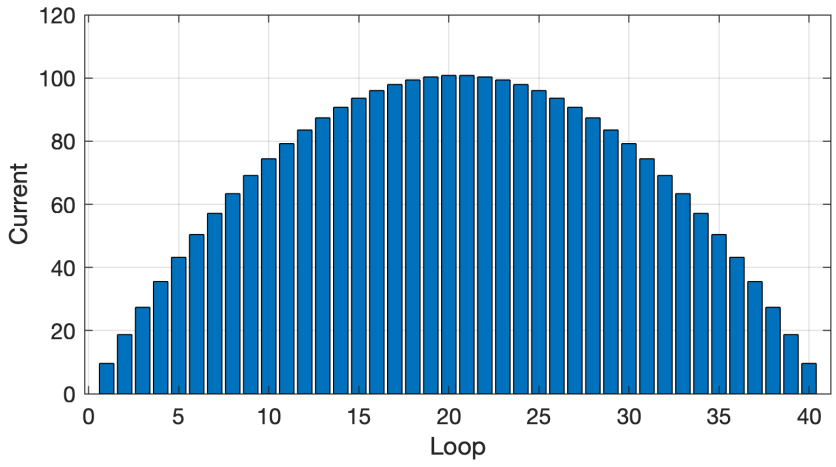
Exercise 1

(a) Create the matrix A for $N = 40$ and $R = 25$. Save the result as `Ex1Amat`.

(b) Create the vector $\mathbf{b}$ for $V_1 = \cdots = V_{40} = 12$. Save the result as `Ex1Bvec`.

(c) Solve the system for the loop currents vector $\mathbf{x}$. Save the result as `Ex1Cvec`. The following command should create the figure below:

```
>> bar(Ex1Cvec), xlabel('Loop'), ylabel('Current'), grid on
```



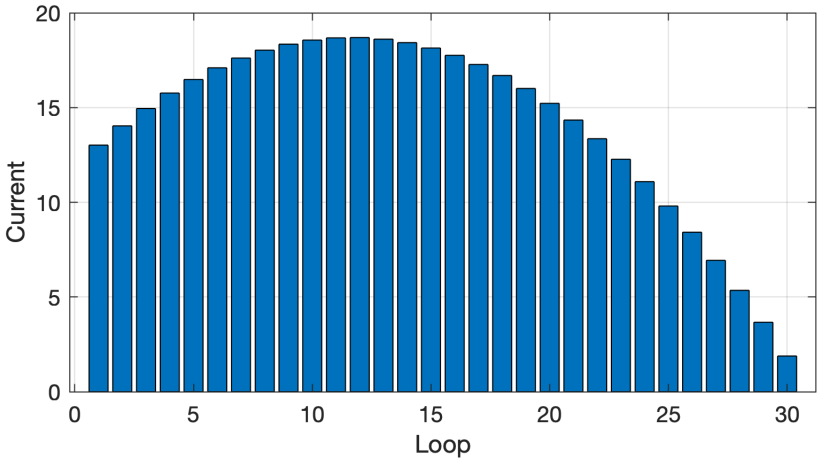
Exercise 2

(a) Create the matrix A for $N = 30$ and $R = 10$. Save the result as `Ex2Amat`.

(b) Create the vector $\mathbf{b}$ such that $V_1 = 120$ and $V_n = 1$ for $n = 2, \ldots, 30$. Save the result as `Ex2Bvec`.

(c) Solve the system for the loop currents vector $\mathbf{x}$. Save the result as `Ex2Cvec`. The following command should create the figure below:

```
>> bar(Ex2Cvec), xlabel('Loop'), ylabel('Current'), grid on
```



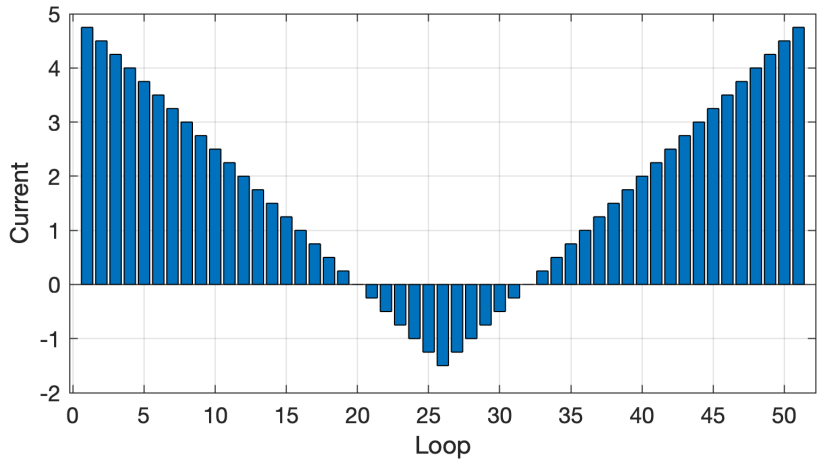
Exercise 3

(a) Create the matrix A for $N = 51$ and $R = 20$. Save the result as `Ex3Amat`.

(b) Create the vector $\mathbf{b}$ such that $V_1 = V_{51} = 100$, $V_{26} = -10$ and $V_n = 0$ for all other n. Save the result as `Ex3Bvec`.

(c) Solve the system for the loop currents vector $\mathbf{x}$. Save the result as `Ex3Cvec`. The following command should create the figure below:

```
>> bar(Ex3Cvec), xlabel('Loop'), ylabel('Current'), grid on
```



Exercise 4

Let $N = 30$ and $V = 12$. Use trial and error to find a value of the resistor R (up to 1 decimal place) such that the maximum loop current in the circuit is 100. Save the value as `Ex4num`. (Note `max` computes the maximum value in a vector.)