

By Don Benson

dbenson@vw.vccs.edu

This program uses the loop current method to solve multiloop circuits, either DC or AC. The method is shown in the following examples. It can be used to solve for currents, voltages, charges (on capacitors), or resistances (impedances for AC). Partsequ(), Mtrxedt(), and Copyto\_h() are used in Circuits(). Place all programs in the same folder, then run Circuits().

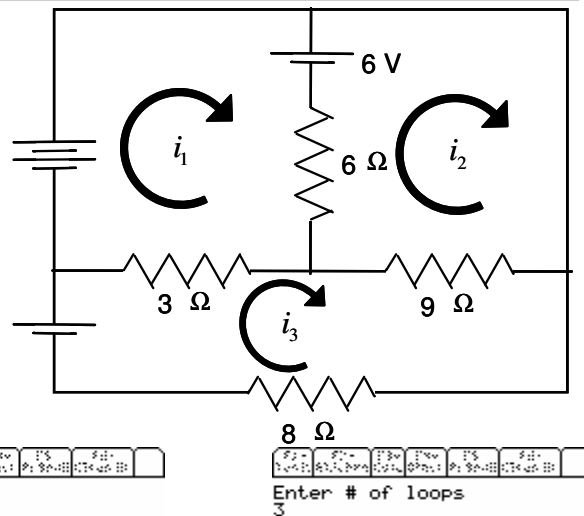
In the 3 loop DC circuit shown, the program will solve for the 3 loop currents shown.

Example 1. DC circuit, all currents unknown

They can be either clockwise or counterclockwise but all must be the same.

The loop currents are the actual currents in the outer branches of the circuit.

The currents in the inner branches can be found from differences in the loop currents. The current in the  $6\ \Omega$  resistor is  $i_1 - i_2$ ,  $i_1 - i_3$  in the  $3\ \Omega$ , and  $i_2 - i_3$  in the  $9\ \Omega$ .



```
1:DC
2:AC
```



```
1:Resistors
2:Capacitors
```



```
1:NO
2:YES
```

Are the values of any of the Currents known?

TYPE OR USE ←→+ + [ENTER] OR [ESC]



```
Resistors in loop #1
Enter 0 when done.
R11=
6
```

MAIN DEGAUTO FUNC 30/30

Enter values for the resistors in the loop one at a time. After all are entered, enter 0 to move to the next step.

Enter values, including polarity, for the emfs in the loop one at a time. Enter 0 to move to the next step.



```
Emfs in loop #1
Enter 0 when done.
e11=
9
```

MAIN DEGAUTO FUNC 30/30



```
Emfs in loop #1
Enter 0 when done.
e12=
-6
```

MAIN DEGAUTO FUNC 30/30

The same procedure is followed for each individual loop.  
Then, using a similar procedure, the resistors common to each pair of loops are entered.

```

F1 F2 F3 F4 F5 F6
1 2 3 4 5 6
Resistors common to
loop #1 and
loop #2
Enter 0 when done.
R121=
6
MAIN DEGAUTO FUNC 30/30

```

```

F1 F2 F3 F4 F5 F6
1 2 3 4 5 6
Resistors common to
loop #1 and
loop #3
Enter 0 when done.
R131=
3
MAIN DEGAUTO FUNC 30/30

```

```

F1 F2 F3 F4 F5 F6
1 2 3 4 5 6
Resistors common to
loop #2 and
loop #3
Enter 0 when done.
R231=
9
MAIN DEGAUTO FUNC 30/30

```

```

F1 F2 F3 F4 F5 F6
1 2 3 4 5 6
i1 = 2.31818
i2 = 2.22727
i3 = 1.5

```

All data can be edited.

```

F1 F2 F3 F4 F5 F6
1 2 3 4 5 6
1:Edit Resistances
2:Edit Currents
3:Edit Emfs
4:Done
5:No Changes

```

```

MAIN DEGAUTO FUNC 30/30
F1 F2 F3
Edit Row Edit Col Done
["(6,3)"] ["(6)"] ["(3)"]
["(6)"] ["(6,9)"] ["(9)"]
["(3)"] ["(9)"] ["(3,9,8)"]

```

```

F1 F2 F3
Edit Row Edit Col Done
["(9,-6)"]
["(6)"]
["(3)"]

```

TYPE OR USE ←→↑↓← (ENTER) OR (ESC)

```

MAIN DEGAUTO FUNC 30/30

```

```

MAIN DEGAUTO FUNC 30/30

```

When editing Resistances and Emfs, they are shown as elements of lists within a matrix in the format shown at right.  
When changing a value, be sure to change it in each matrix element in which it appears. The program used to edit the matrix Mtrxedt(), is a simplified version of my program, Mtrxedtr().

$R_{11}$  = all resistors in loop 1  
 $R_{12} = R_{21}$  = all resistors common to loops 1 and 2  
 etc.  
 $\mathcal{E}_1$  = all emfs in loop 1  
 etc.

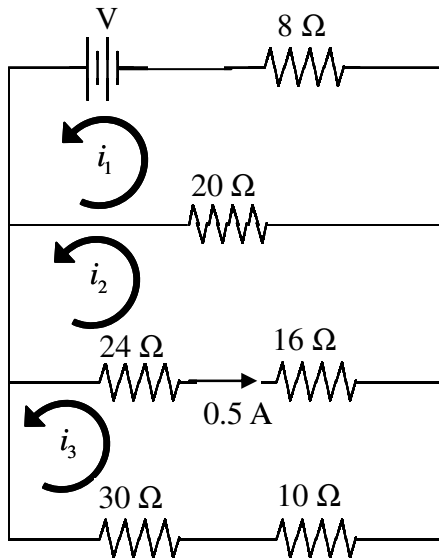
$$\begin{bmatrix} \{R_{11}\} & \{R_{12}\} & \{R_{13}\} \\ \{R_{21}\} & \{R_{22}\} & \{R_{23}\} \\ \{R_{31}\} & \{R_{32}\} & \{R_{33}\} \end{bmatrix}$$

$$\begin{bmatrix} \{\mathcal{E}_1\} \\ \{\mathcal{E}_2\} \\ \{\mathcal{E}_3\} \end{bmatrix}$$

### Example 2. DC circuit, one current known

In this DC circuit, the current in the 24 and 16  $\Omega$  resistors is given as 0.5 A.

So  $i_2 - i_3 = 0.5$ , or  $i_2 = i_3 + 0.5$



1:DC  
2:AC

1:DC  
2:AC

MAIN DEGAUTO FUNC  
1:Resistors  
2:Capacitors

1:Resistors  
2:Capacitors

TYPE OR USE ←+1 + CENTER) OR (ESC)  
Enter # of loops  
3

Enter # of loops  
3

How many Currents have  
known values?  
1

MAIN DEGAUTO FUNC 30/30  
Enter # of Currents  
1 for i1, 2 for i2, etc  
i#  
2  
Current value=  
i3+.5

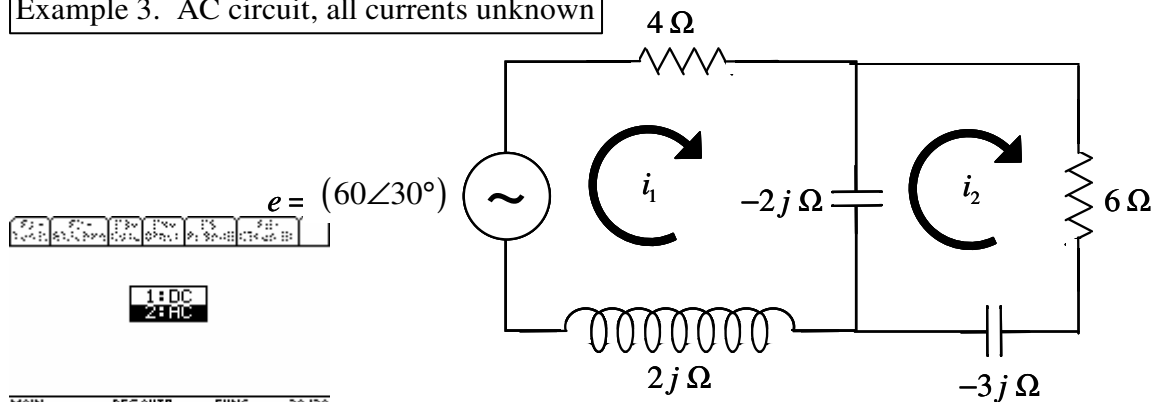
MAIN DEGAUTO FUNC 30/30  
Enter resistors and  
as in example 1. The  
entry of the unknown  
emf in loop 1 is shown  
at right.

MAIN DEGAUTO FUNC 30/30  
Emfs in loop #1  
Enter 0 when done.  
e11=  
0

v=36.  
i1=2.  
i3=.5

MAIN DEGAUTO FUNC 30/30

### Example 3. AC circuit, all currents unknown



MAIN DEGAUTO FUNC 30/30

Enter values as complex numbers, either (r∠θ) or x+yi

MAIN DEGAUTO FUNC 20/30

Impedances in loop #1

Enter 0 when done.

Z11=  
2j

MAIN DEGAUTO FUNC 30/30

Emfs in loop #1

Enter 0 when done.

e11=  
(60∠30)

MAIN DEGAUTO FUNC 30/30

Enter # of loops

2

MAIN DEGAUTO FUNC 30/30

Impedances in loop #1

Enter 0 when done.

Z12=  
4

MAIN DEGAUTO FUNC 30/30

Enter values for the other loop.

MAIN DEGAUTO FUNC 30/30

Are the values of any of the Currents known?

1: NO

2: YES

Are the values of any of the Currents known?

TYPE OR USE ←+1+ [ENTER] OR [ESC]

Impedances in loop #1

Enter 0 when done.

Z13=  
-2j

MAIN DEGAUTO FUNC 30/30

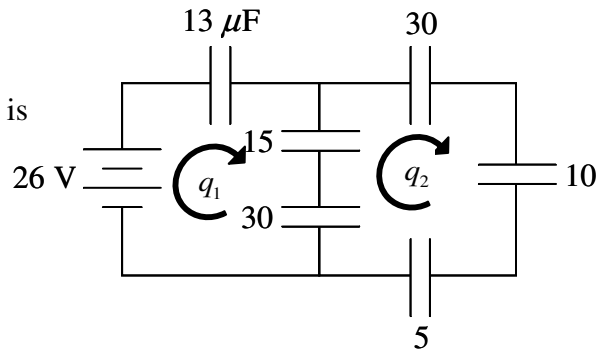
i1=(13.6188 ∠ 25.7321)

i2=(3.48743 ∠ -24.4623)

MAIN DEGAUTO FUNC 20/30

# Example 4. DC capacitor circuit

Data is entered as before. If capacitance is in  $\mu\text{F}$ , charges will be in  $\mu\text{C}$ .



1:DC  
2:AC

MAIN DEGAUTO FUNC

1:Resistors  
2:Capacitors

Enter # of loops  
2

1:NO  
2:YES

Are the values of any  
of the Charges known?

qq1=169.  
qq2=39.

Capacitors in loop #1  
Enter 0 when done.  
C11=  
13

Continue as before.

MAIN DEGAUTO FUNC 30/30

$qq1$  = charge on  $13\mu\text{F}$   
 $qq2$  = charge on  $5\mu\text{F}$ ,  $10\mu\text{F}$ ,  $30\mu\text{F}$   
 $qq1 - qq2$  = charge on  $15\mu\text{F}$ ,  $30\mu\text{F}$   
 $C_{eq} = \frac{qq1}{e} = \frac{169\mu\text{C}}{26\text{V}} = 6.5\mu\text{F}$

MAIN DEGAUTO FUNC 12/159