AOL Computational Physics

Group 12 LA-09

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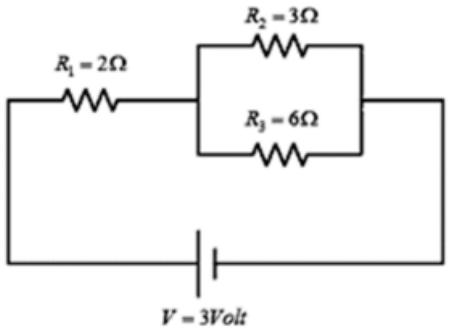
Problem 1

From the following circuit, proof your manual calculation using PPE simulation to calculate parameters below:

1. Total Current flow in the circuit

2. Potential difference at each end of the resistance

3. The amount of current that passes through resistance 2 and resistance 3



Solution:

1. **Total Current flow**

$V = Itotal \times Rtotal$

$V = Itotal \times \left(R1 + (\frac{1}{3\Omega} + \frac{1}{6\Omega})\right)$

$3V = Itotal \times \left(2\Omega + (\frac{1}{3\Omega} + \frac{1}{6\Omega})\right)$

$3V = Itotal \times (2\Omega + 2\Omega)$

$3V = Itotal \times 4\Omega$

$Itotal = \frac{3V}{4\Omega}$

$Itotal = 0.75A$

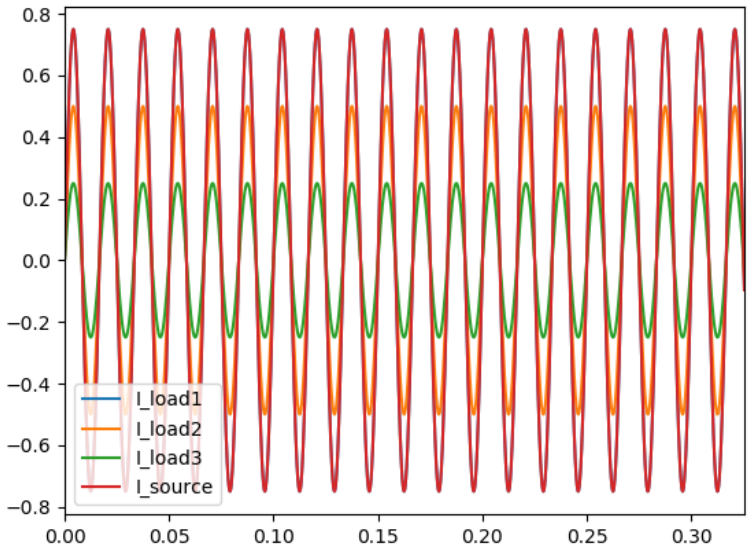
Circuit Topology

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	wire	wire	wire	Resistor_load1	wire	Ammeter_load1	wire	wire	wire	wire	wire	Resistor_load2	wire	Ammeter_load2	wire	wire	wire	wire	wire	
2	wire		wire				wire		wire		wire				wire		wire		wire	
3	wire		wire	Voltmeter_load1	wire	wire	wire		wire		wire	Voltmeter_load2	wire	wire	wire		wire		wire	
4	wire								wire								wire		wire	
5	wire								wire								wire		wire	
6	wire								wire	wire	wire	Resistor_load3	wire	Ammeter_load3	wire	wire	wire		wire	
7	wire										wire				wire				wire	
8	wire										wire	Voltmeter_load3	wire	wire	wire				wire	
9	wire																		wire	
10	wire																		wire	
11	wire																		wire	
12	wire																		wire	
13	wire																		wire	
14	wire	wire	wire	Resistor_Rfeed	wire	VoltageSource_acsource	wire	wire	wire	wire	wire	Resistor_Rsource	wire	Ammeter_source	wire	wire	wire	wire	wire	
15			wire						wire											
16			wire	wire	Voltmeter_source	wire	wire	wire	wire											
17																				

Parameter

Resistor	load1	1D	2.0				
Resistor	load2	1L	3.0				
Resistor	load3	6L	6.0				
Resistor	Rfeed	14D	0.001				
Resistor	Rsource	14L	0.001				
Ammeter	load1	1F	Positive polarity towards (cell) = 1G				
Ammeter	load2	1N	Positive polarity towards (cell) = 1O				
Ammeter	load3	6N	Positive polarity towards (cell) = 6O				
Ammeter	source	14N	Positive polarity towards (cell) = 14M				
Voltmeter	load1	3D	Rated voltage level to be measured = 1000.0	Positive polarity towards (cell) = 3C			
Voltmeter	load2	3L	Rated voltage level to be measured = 1000.0	Positive polarity towards (cell) = 3K			
Voltmeter	load3	8L	Rated voltage level to be measured = 1000.0	Positive polarity towards (cell) = 8K			
Voltmeter	source	16E	Rated voltage level to be measured = 1000.0	Positive polarity towards (cell) = 16D			
VoltageSource	acsource	14F	Peak (Volts) = 3.000000	Frequency (Hertz) = 60.000000	Phase (degrees) = 0.000000	Dc offset = 0.000000	Positive polarity towards (cell) = 14E

Total Current from PPE Simulation (red line)



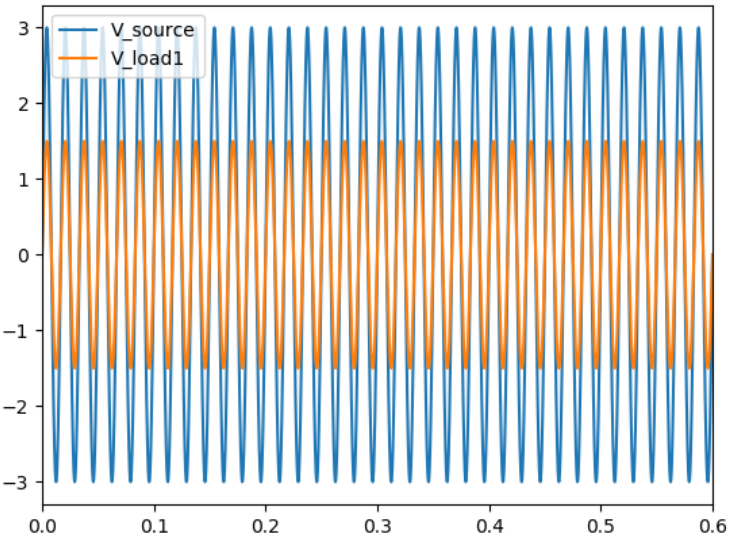
2. **Potential difference at each end of the resistance**

$$V_{R1} = I_1 \times R_1$$

$$V_{R1} = 0.75A \times 2\Omega$$

$V_{R1} = 1.5V$

Potential difference at R1 from PPE Simulation

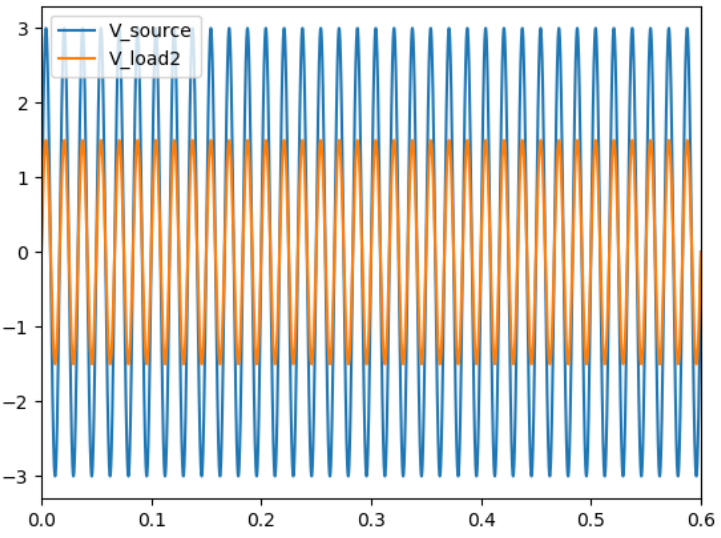


$V_{R2} = I_2 \times R_2$

$V_{R2} = 0.5A \times 3\Omega$

$V_{R2} = 1.5V$

Potential difference at R2 from PPE Simulation

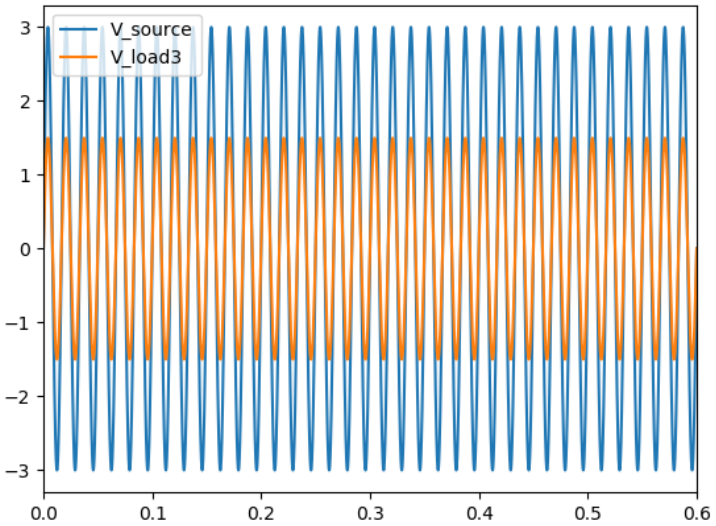


$V_{R3} = I_3 \times R_3 = 0.25A \times 6\Omega = 1.5V$

$V_{R3} = 0.25A \times 6\Omega$

$V_{R3} = 1.5V$

Potential difference at R3 from PPE Simulation



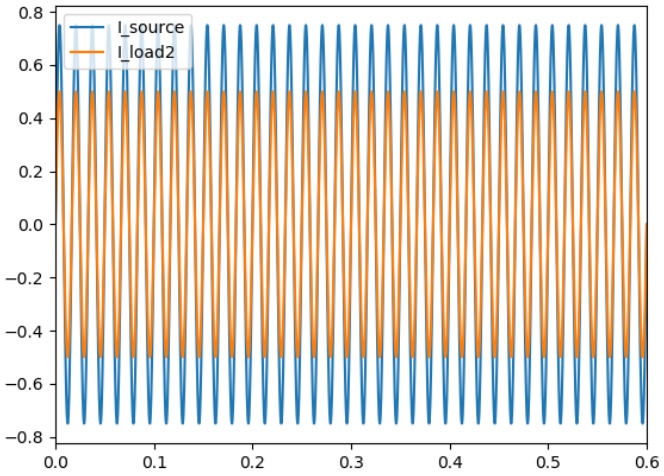
3. **The amount of current that passes through resistance 2 and resistance 3**

$I_{R2} = \frac{V_{R2}}{R2}$

$I_{R2} = \frac{1.5V}{3\Omega}$

$I_{R2} = 0.5A$

The amount of current that passes through resistance 2 from PPE Simulation

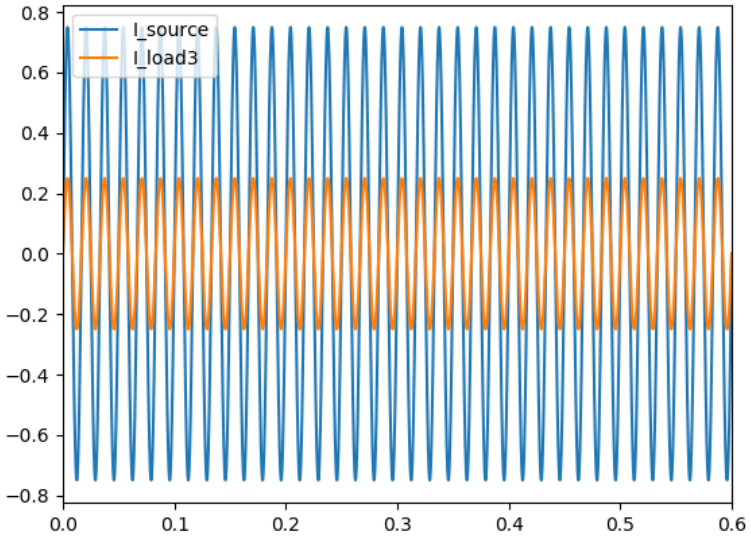


$$I_{R3} = \frac{V_{R3}}{R3}$$

$$I_{R3} = \frac{1.5V}{6\Omega}$$

$$I_{R3} = 0.25A$$

The amount of current that passes through resistance 3 from PPE Simulation



Total current that passes through resistance 2 and resistance 3

$$I_{R23} = I_{R2} + I_{R3}$$

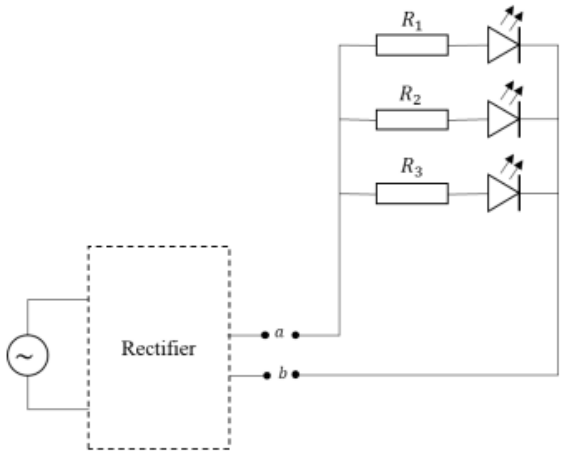
$$I_{R23} = 0.5A + 0.25A$$

$$I_{R23} = 0.75A$$

Problem 2

You are planning to conduct a small electronic project. You are planning to make a simple LED circuit (see diagram). The circuit contains three green LED lights that connected using parallel connections. From the LED specification sheet, you know that the LED will works on a minimum voltage of 2 *V*. Also, you gain information that the LED will break if the current that flow through it exceed 20 *mA*. For that, you need to use some resistor to limit the current that flow through the LED.

To power the circuit, you are planning to use a micro hydro generator that you already have. However, you realize that you need to convert the current from AC to DC so you can light up the LED. But you don't have the proper converter at the moment. So, you decide to make your own rectifier, a basic RLC rectifier, from only the components you have (see table) at hand. Assume that your component supply is large enough, so you can use any number of each component.



Assume that your LED does not have any internal resistance. The LED circuit will be connected to the rectifier at point *a* and *b* (see diagram). The generator has an output of 5 *V* with frequency of 20 *Hz*. So, what is your solution for the basic RLC rectifier? Assume that each component on the table (including the EMF) has internal resistance of 0.1 Ω.

No	Component	Value
1	Resistor	3 Ω
2		24 Ω
3		36 Ω
4		100 Ω
5		130 Ω
6		220 Ω
7		510 Ω
8	Capacitor	1.0 μF
9		3.3 μF
10		22 μF
11	Inductor	2 μH
12		5.1 μH
13		2 mH
14		400 mH

Solution:

Diketahui :

- V_{LED} = 2V (minimal 2V)
- $V_{generator} = 5V$
- $I_{LED1,\,2,\,3} = 20\,mA = 0.02\,A\,(maksimum\ 20\,mA\ atau\ 0.02A)$
- $f_{generator} = 20\,Hz$
- r (internal resistance) = 0.1Ω

1. Resistor LED1, Resistor LED2, Resistor LED3

$$R_{LED1,\,2,\,3} = \frac{V_{generator} - V_{LED}}{I_{LED1,\,2,\,3}}$$

$$R_{LED1,\,2,\,3} = \frac{5\,V - 2\,V}{0.02\,A}$$

$$R_{LED1,\,2,\,3} = 150\Omega$$

Dari nilai resistor pada tabel komponen yang mendekati hasil $R_{LED1,\,2,\,3} = 150\Omega$ adalah 130Ω dan 220Ω. Maka perlu dibandingkan nilai resistor yang dapat menghambat arus LED (arus LED tidak melebihi 20 mA atau 0.02 A).

- R = 130Ω

$$I_{LED1,\,2,\,3} = \frac{V_{generator} - V_{LED}}{R_{LED1,\,2,\,3}}$$

$$I_{LED1,\,2,\,3} = \frac{5\,V - 2\,V}{130\Omega}$$

$$I_{LED1,\,2,\,3} = 0.023\ \text{A}$$

(R = 130Ω, memiliki arus yang mengalir melalui LED 0.023 A > 0.02 A. Sehingga melebihi batas maksimum arus)

- R = 220Ω

$$I_{LED1,\,2,\,3} = \frac{V_{generator} - V_{LED}}{R_{LED1,\,2,\,3}}$$

$$I_{LED1,\,2,\,3} = \frac{5\,V - 2\,V}{220\Omega}$$

$$I_{LED1,\,2,\,3} = 0.013\ \text{A}$$

(R = 220Ω, memiliki arus yang mengalir melalui LED 0.013 A < 0.02 A. Sehingga tidak melebihi batas maksimum arus)

Maka kami menggunakan nilai Resistor sebesar 220Ω untuk Resistor LED :

$R_{LED1} = 220\Omega$

$R_{LED2} = 220\Omega$

$R_{LED3} = 220\Omega$

2. **Total arus listrik yang mengalir pada circuit LED paralel**

$I_{total} = I_{LED1} + I_{LED2} + I_{LED3}$

$I_{total} = 0.02\,A + 0.02\,A + 0.02\,A$

$I_{total} = 0.06$ A

3. **Tegangan atau voltage pada setiap resistor LED paralel**

$V_{total} = V_{LED1} = V_{LED2} = V_{LED3}$

$V_{total} = 5\,V$

4. **Nilai Komponen kapasitor dan Induktor yang digunakan pada circuit**

Capacitor = 22 μF atau 0.000022 F

Inductor = 400 mH atau 0.4 H

5. **Peak Voltage**

Peak Voltage = V * $\sqrt{2}$

Peak Voltage = 7.07 Volt

PPE Simulation

Circuit Topology

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Inductor_	wire	Ammeter	wire	wire	wire	wire	wire	wire	wire	Resistor_	wire	Ammeter	wire	wire	wire	wire	wire
2	Diode_D1					wire		wire		wire				wire		wire		wire
3	wire					wire		wire		wire	Voltmeter	wire	wire	wire		wire		wire
4	wire	wire	wire			wire		wire								wire		wire
5	Resistor_Rsource		wire			wire		wire								wire		wire
6	wire		wire			wire		wire	wire	wire	Resistor_	wire	Ammeter	wire	wire	wire		wire
7	wire		Voltmeter_source			wire				wire				wire				wire
8	wire		wire			wire				wire	Voltmeter	wire	wire	wire				wire
9	VoltageSource_Vsource		wire			wire												wire
10	wire		wire			wire												wire
11	wire	wire	wire			wire	wire	wire	wire	wire	Resistor_	wire	Ammeter	wire	wire	wire	wire	wire
12	wire									wire				wire				wire
13	wire									wire	Voltmeter	wire	wire	wire				wire
14	wire																	wire
15	wire																	wire
16	wire	wire	wire	wire	wire	wire	wire	wire	wire	wire	Capacitor	wire	wire	Resistor_	wire	wire	wire	wire

Parameter

1. Component type: Ammeter
   Component name: Isource
   Component position: 1C
   Positive direction of current: 1D
   Edit parameters

2. Component type: Ammeter
   Component name: load1
   Component position: 1M
   Positive direction of current: 1N
   Edit parameters

3. Component type: Ammeter
   Component name: load2
   Component position: 6M
   Positive direction of current: 6N
   Edit parameters

4. Component type: Ammeter
   Component name: load3
   Component position: 11M
   Positive direction of current: 11N
   Edit parameters

5. Component type: Capacitor
   Component name: filter
   Component position: 16K
   Capacitor value: 2.2e-05
   Positive polarity: 16L
   Edit parameters

6. Component type: Diode
   Component name: D1
   Component position: 2A
   Voltage level: 5.0
   Direction of cathode: 1A
   Edit parameters

7. Component type: Inductor
   Component name: filter
   Component position: 1A
   Inductor value: 0.4
   Edit parameters

8. Component type: Resistor
   Component name: Cfilter
   Component position: 16N
   Resistor value: 0.1
   Edit parameters

9. Component type: Resistor
Component name: Rsource
Component position: 5A
Resistor value: 0.1

Edit parameters

10. Component type: Resistor
Component name: load1
Component position: 1K
Resistor value: 220.0

Edit parameters

11. Component type: Resistor
Component name: load2
Component position: 6K
Resistor value: 220.0

Edit parameters

12. Component type: Resistor
Component name: load3
Component position: 11K
Resistor value: 220.0

Edit parameters

13. Component type: VoltageSource
Component name: Vsource
Component position: 9A
Peak value: 7.07
Frequency: 20.0
Phase angle: 0.0
Dc offset: 0.0
Positive polarity: 8A

Edit parameters

14. Component type: Voltmeter
Component name: diode1
Component position: 3K
Voltage level: 5.0
Positive direction of voltage: 3L

Edit parameters

15. Component type: Voltmeter
Component name: diode2
Component position: 8K
Voltage level: 5.0
Positive direction of voltage: 8L

Edit parameters

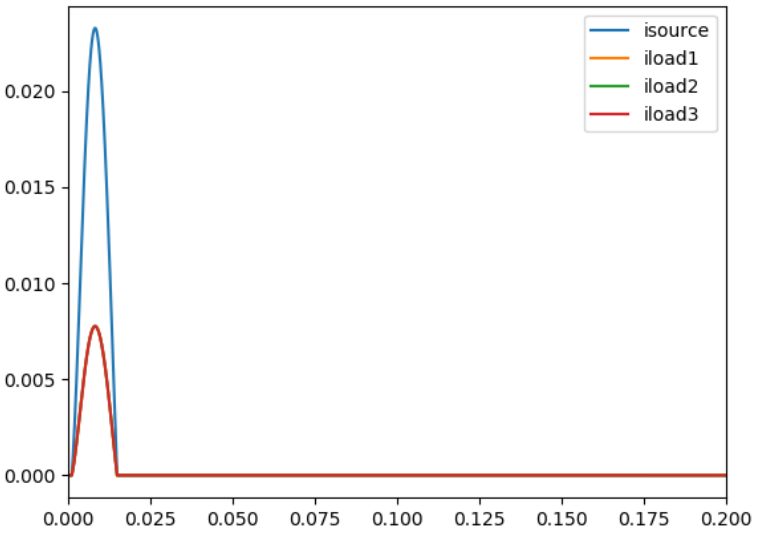
16. Component type: Voltmeter
Component name: diode3
Component position: 13K
Voltage level: 5.0
Positive direction of voltage: 13L

Edit parameters

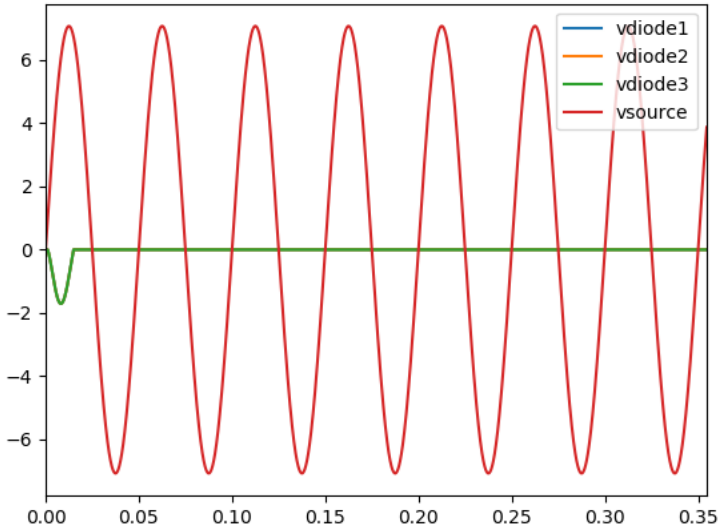
17. Component type: Voltmeter
Component name: source
Component position: 7C
Voltage level: 5.0
Positive direction of voltage: 6C

Edit parameters

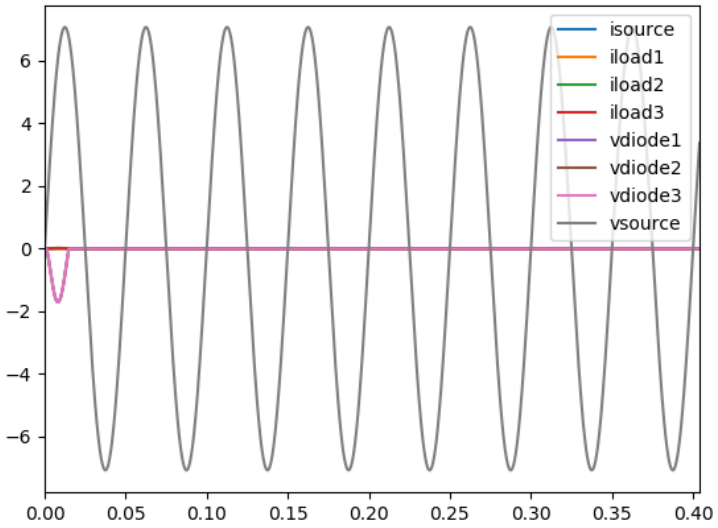
- **Current RLC Rectifier**



- **Voltage RLC Rectifier**



- **RLC Rectifier**



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