

Presentasi Tugas Besar

Kelompok 02 | EL2008

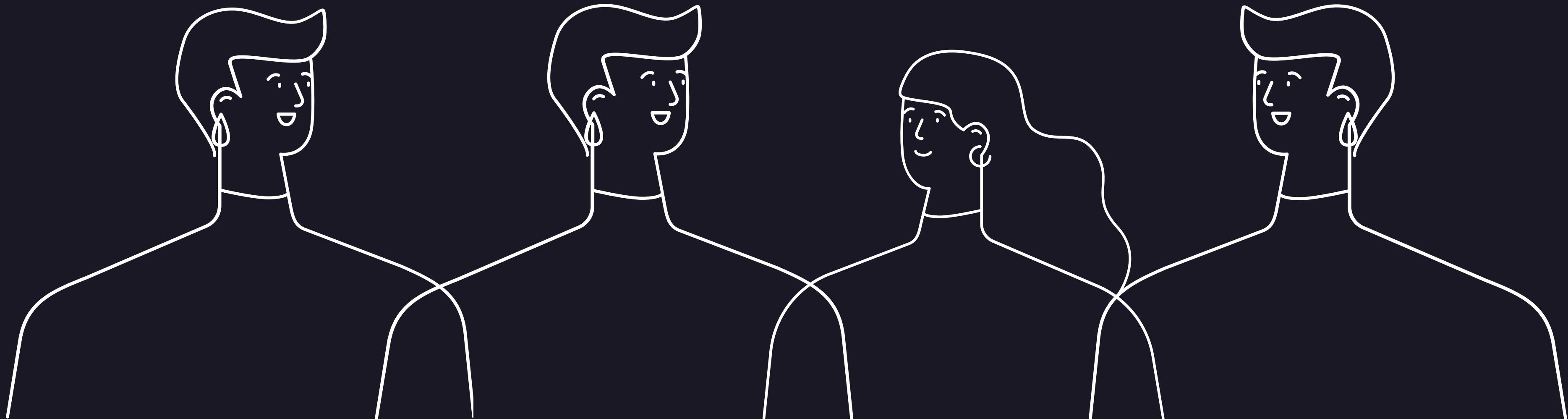
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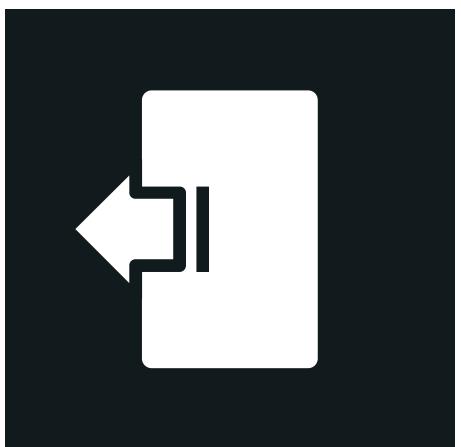


DISCUSSION OUTLINE

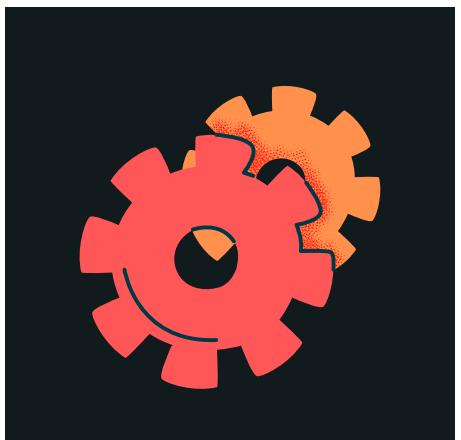


Simulator Rangkaian

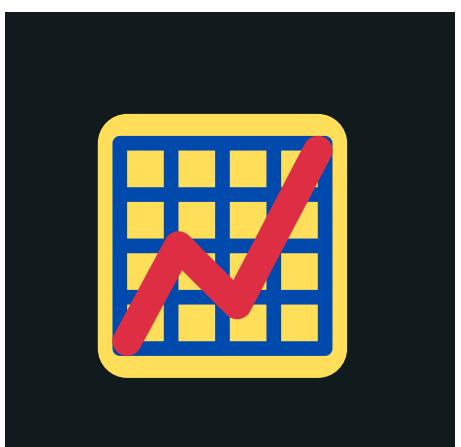
Pendahuluan
Jenis dan spesifikasi rangkaian
Tampilan GUI
Hasil Simulasi
Demonstrasi
Kesimpulan



**Graphical User
Interface (GUI)**



Bahasa C

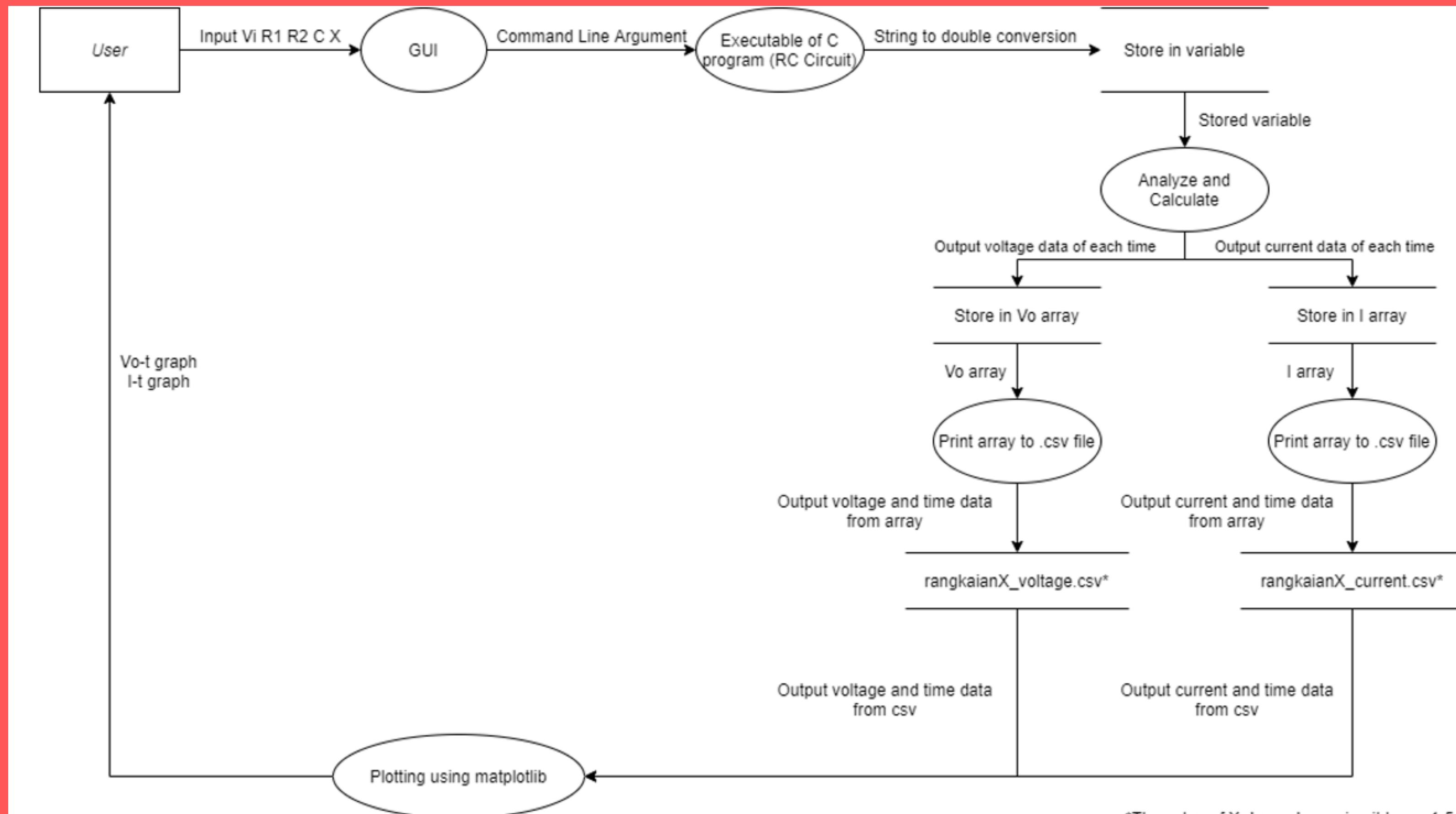


Matplotlib python

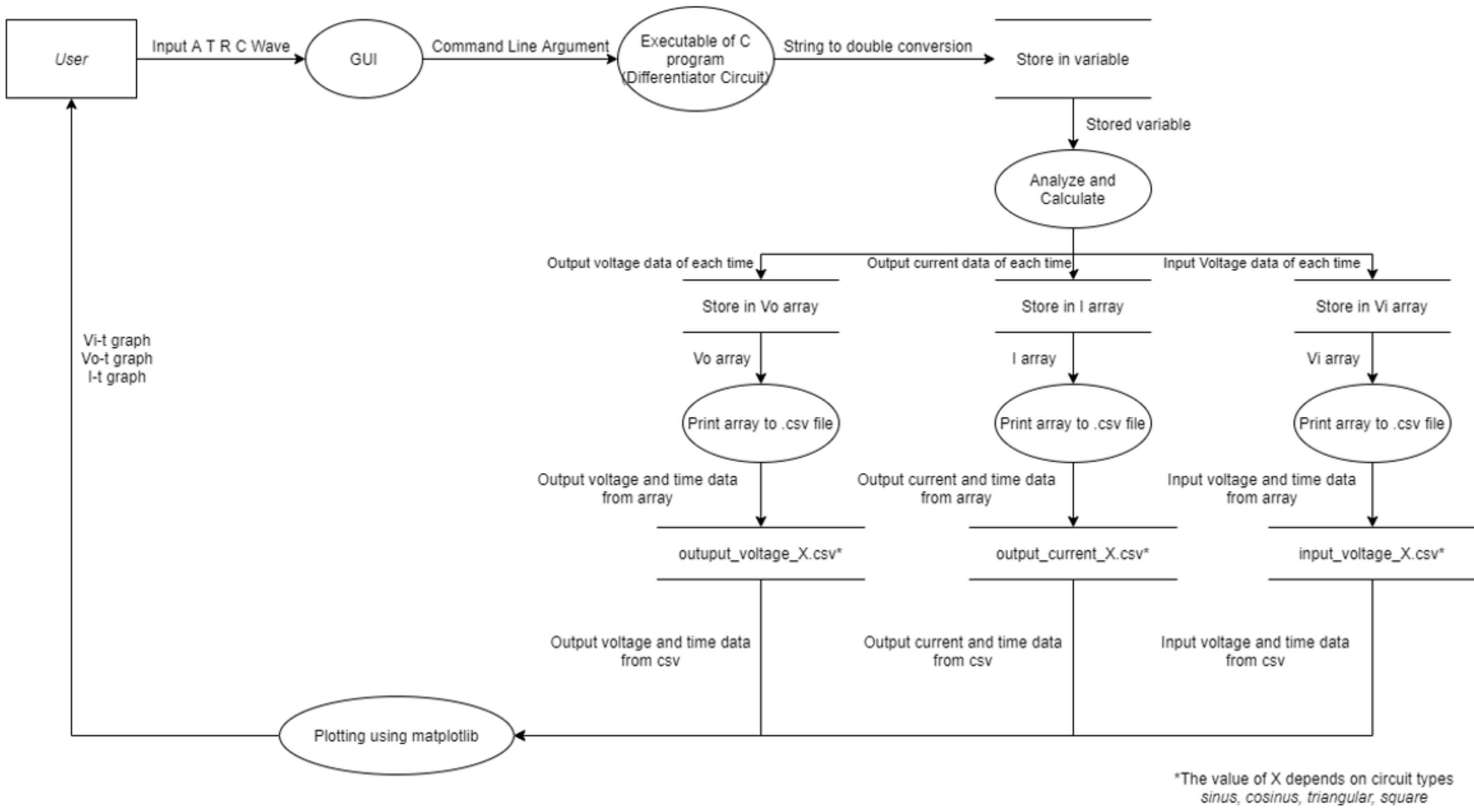
Pendahuluan

**SEKILAS TENTANG SIMULATOR
RANGKAIAN**

DATA FLOW RANGKAIAN RC

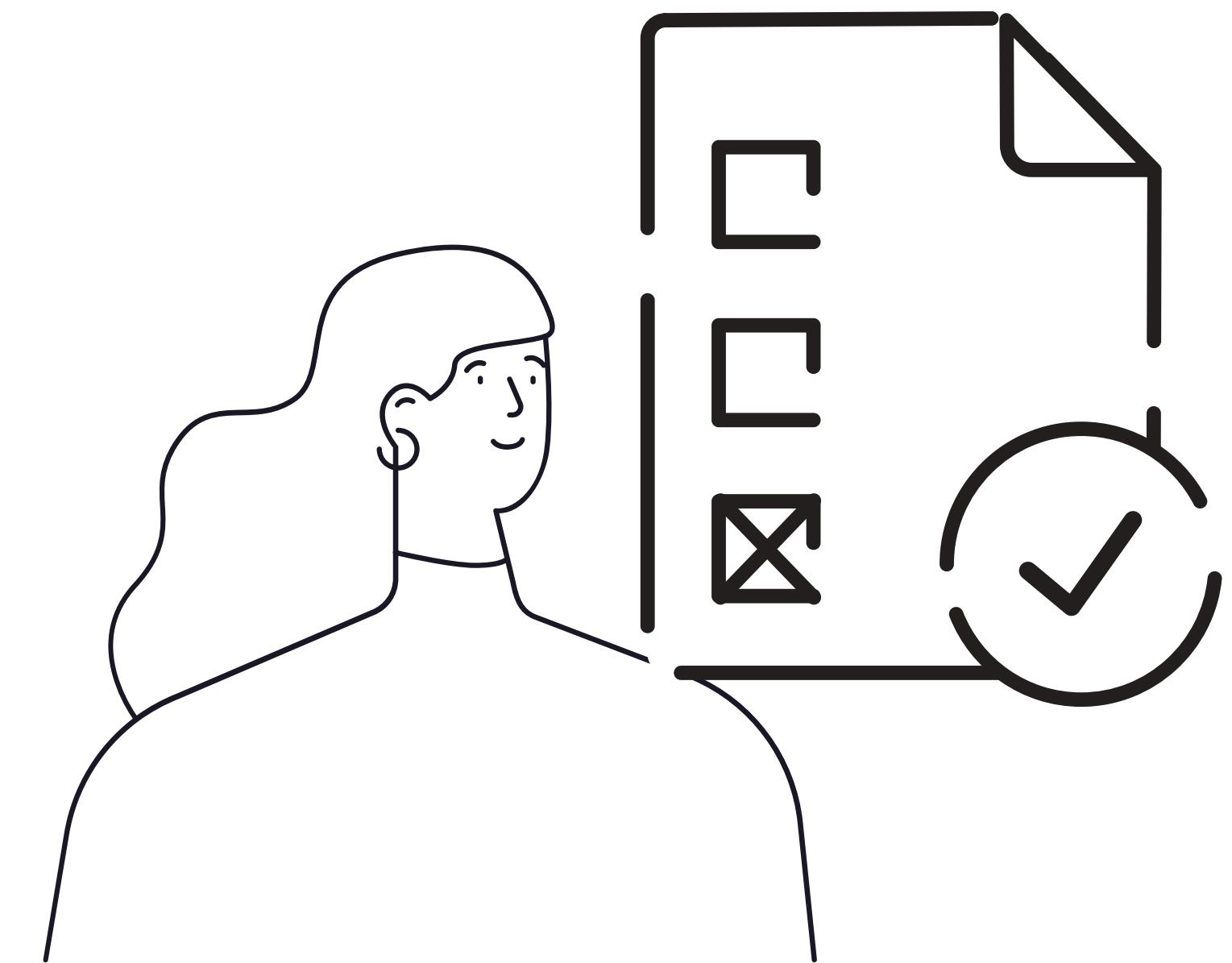


*The value of X depends on circuit types 1-5



DATA FLOW RANGKAIAN DIFFERENSIATOR

Jenis-jenis Rangkaian



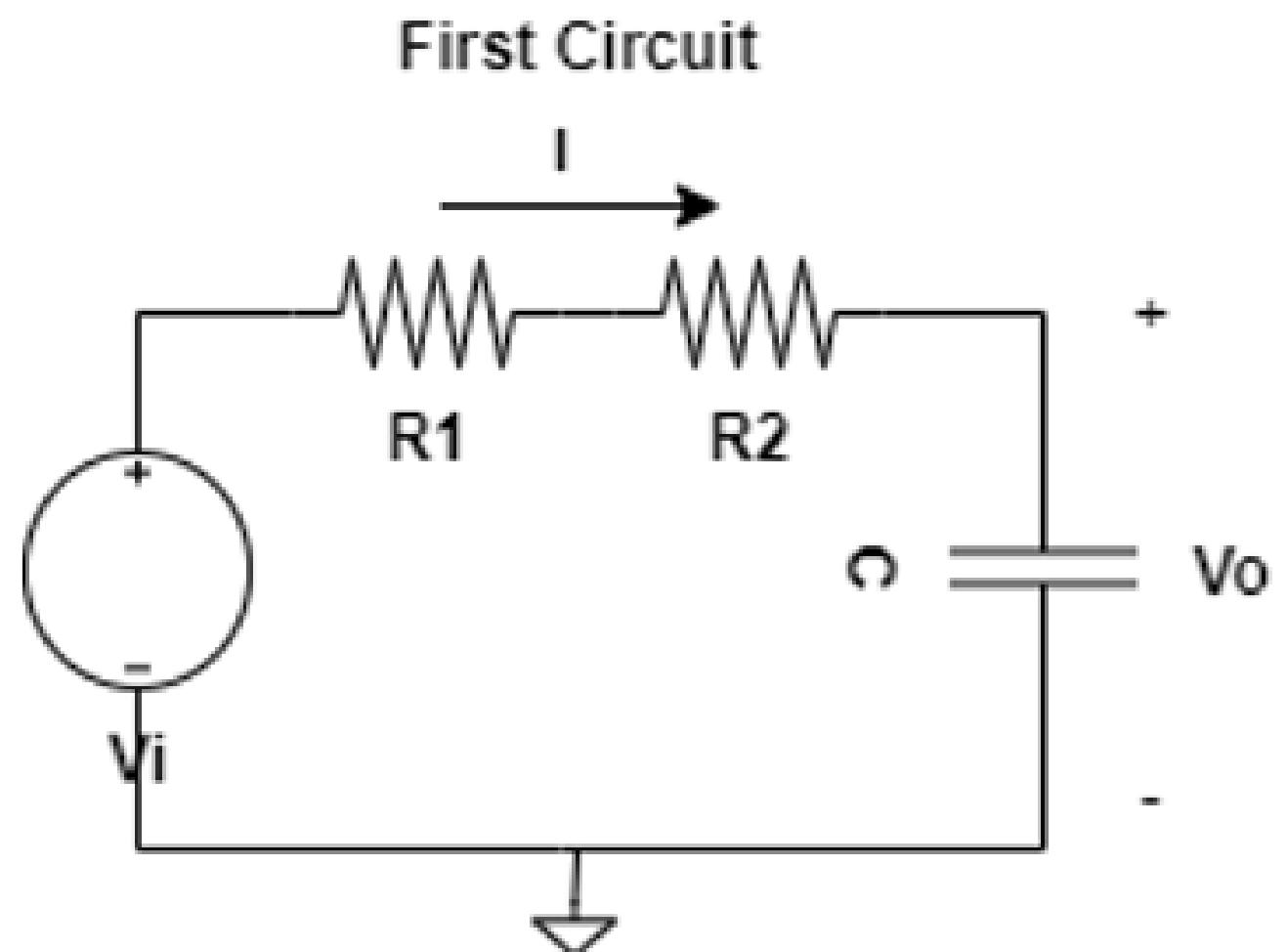
Input User:

- Tegangan sumber
 V_i
- Resistansi R_1
- Resistansi R_2
- Kapasitansi C

Output:

- Gejala transien tegangan (error<2%)
- Gejala transien arus (error<2%)

Rangkaian RC Tipe 01



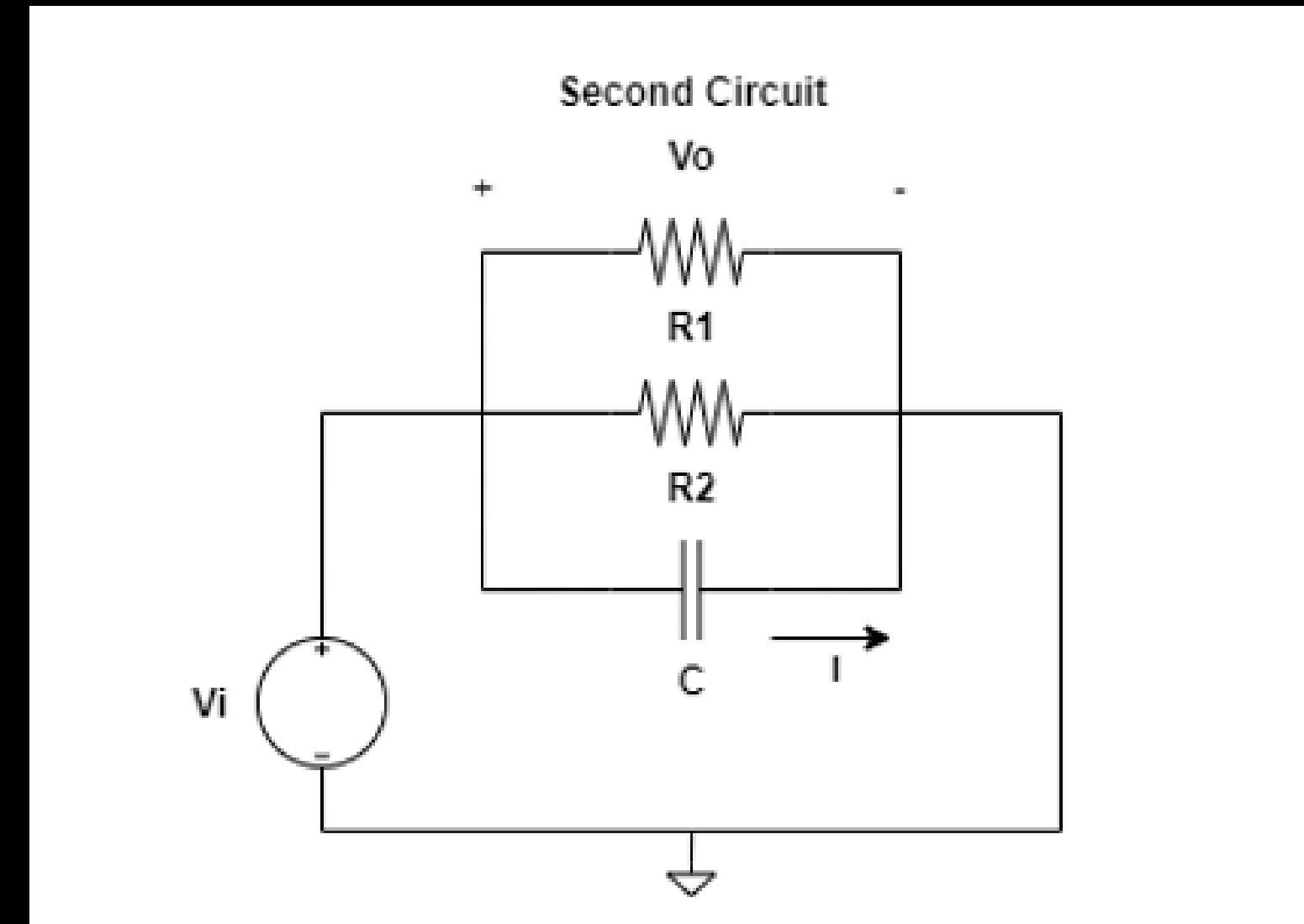
Input User:

- Tegangan sumber V_i
- Resistansi R_1
- Resistansi R_2
- Kapasitansi C

Output:

- Gejala transien tegangan (error<2%)
- Gejala transien arus (error<2%)

Rangkaian RC Tipe 02



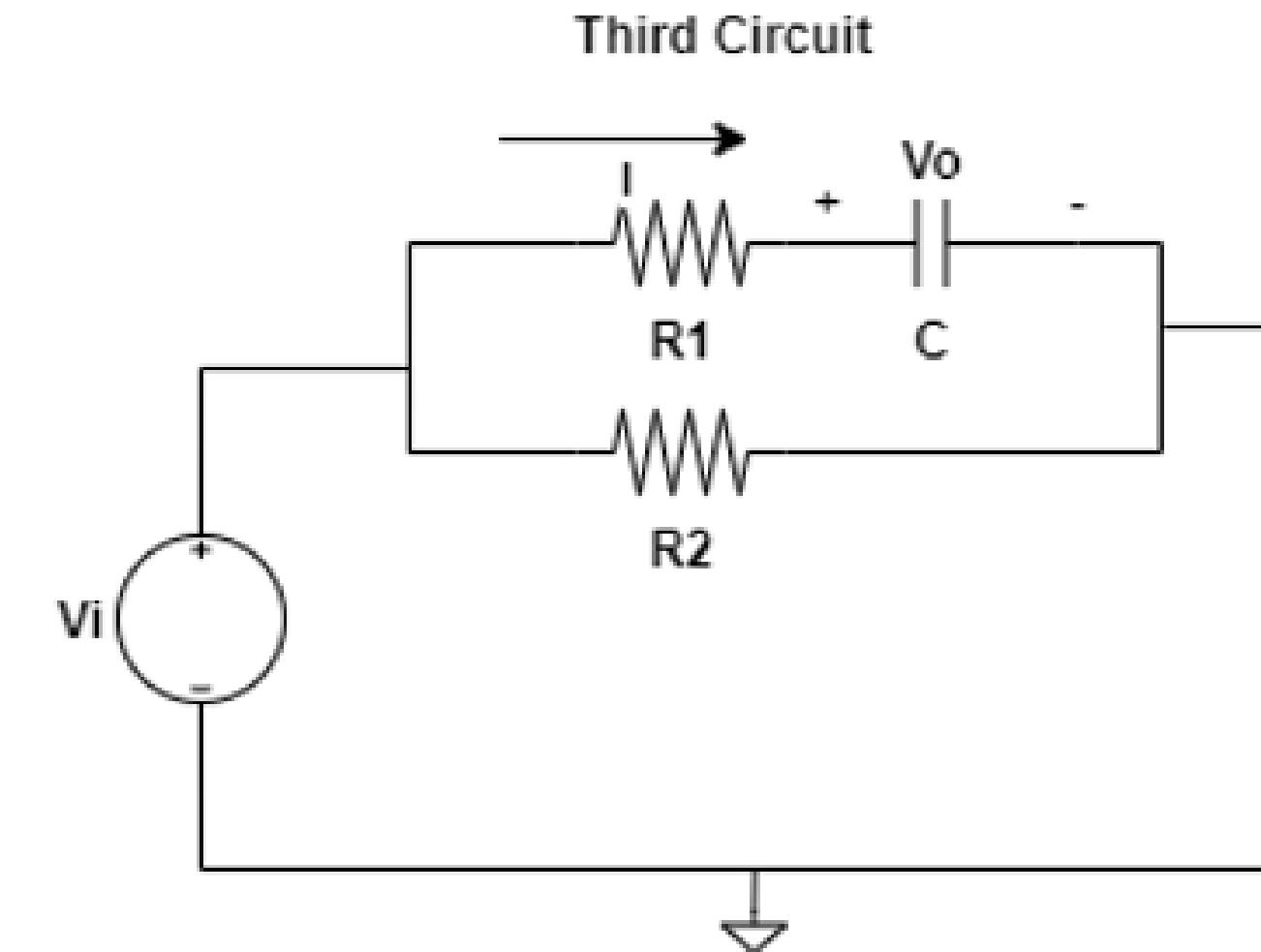
Input User:

- Tegangan sumber
 V_i
- Resistansi R_1
- Resistansi R_2
- Kapasitansi C

Output:

- Gejala transien tegangan (error<2%)
- Gejala transien arus (error<2%)

Rangkaian RC Tipe 03



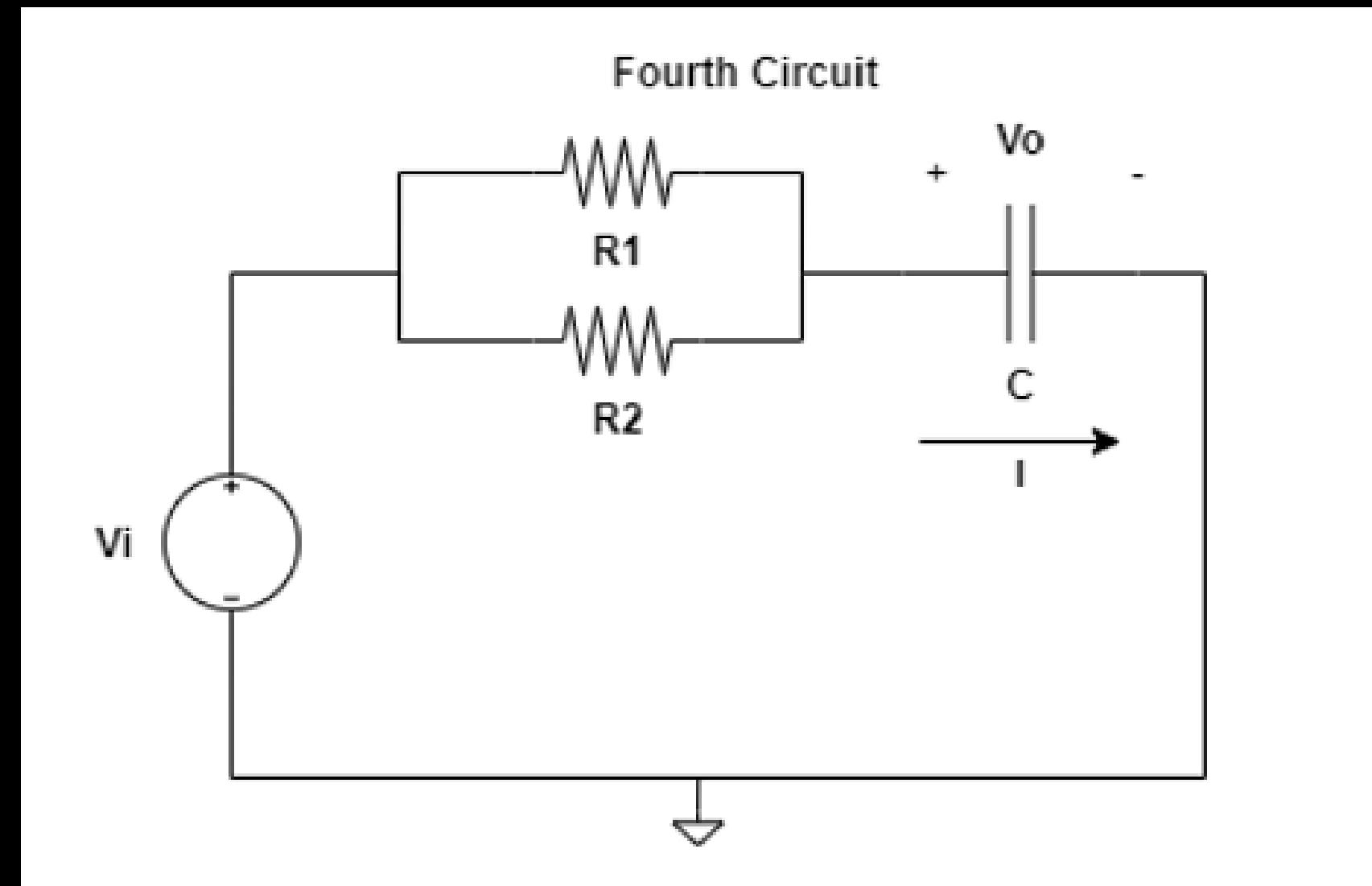
Input User:

- Tegangan sumber
 V_i
- Resistansi R_1
- Resistansi R_2
- Kapasitansi C

Output:

- Gejala transien tegangan (error<2%)
- Gejala transien arus (error<2%)

Rangkaian RC Tipe 04



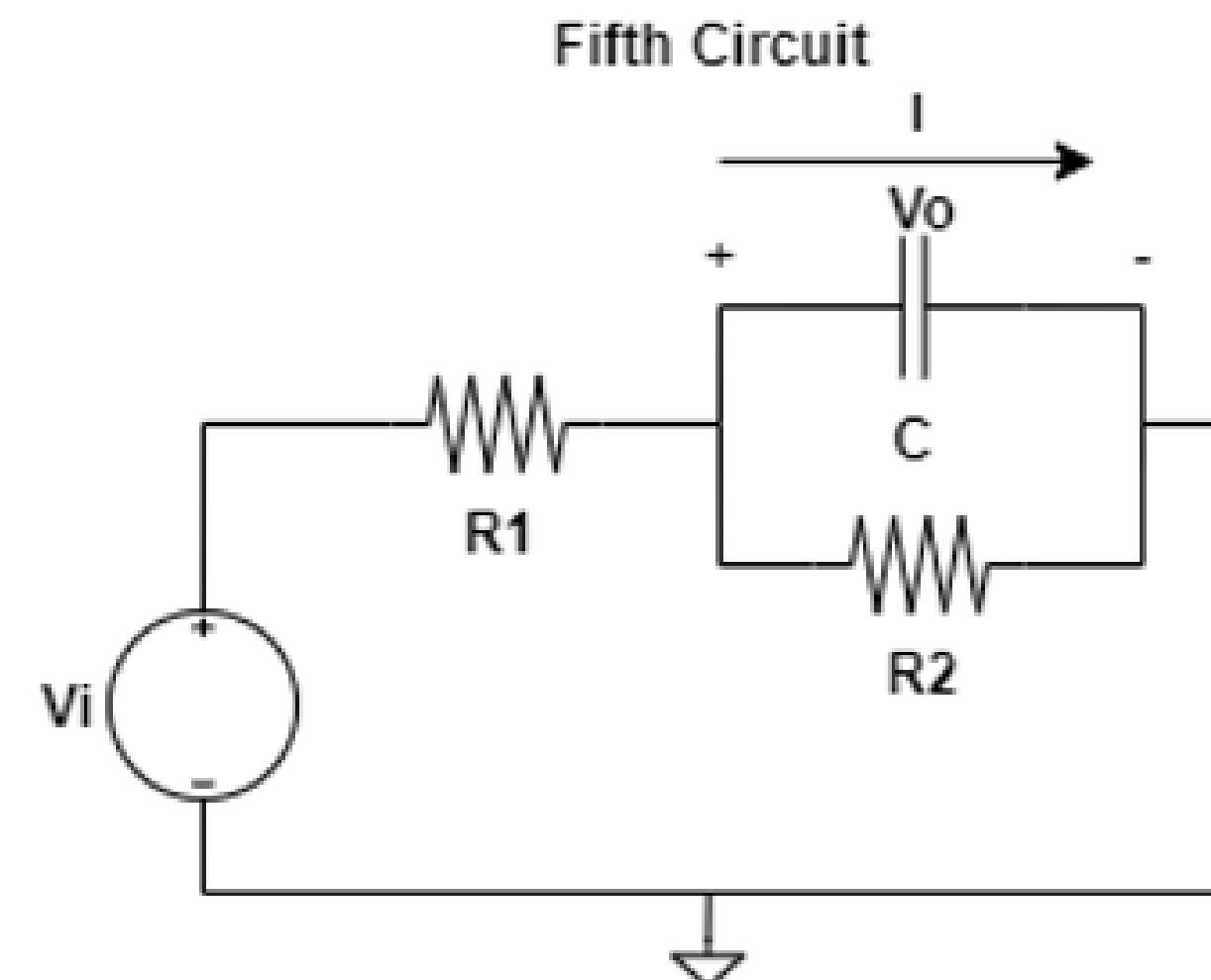
Input User:

- Tegangan sumber
 V_i
- Resistansi R_1
- Resistansi R_2
- Kapasitansi C

Output:

- Gejala transien tegangan (error<2%)
- Gejala transien arus (error<2%)

Rangkaian RC Tipe 05



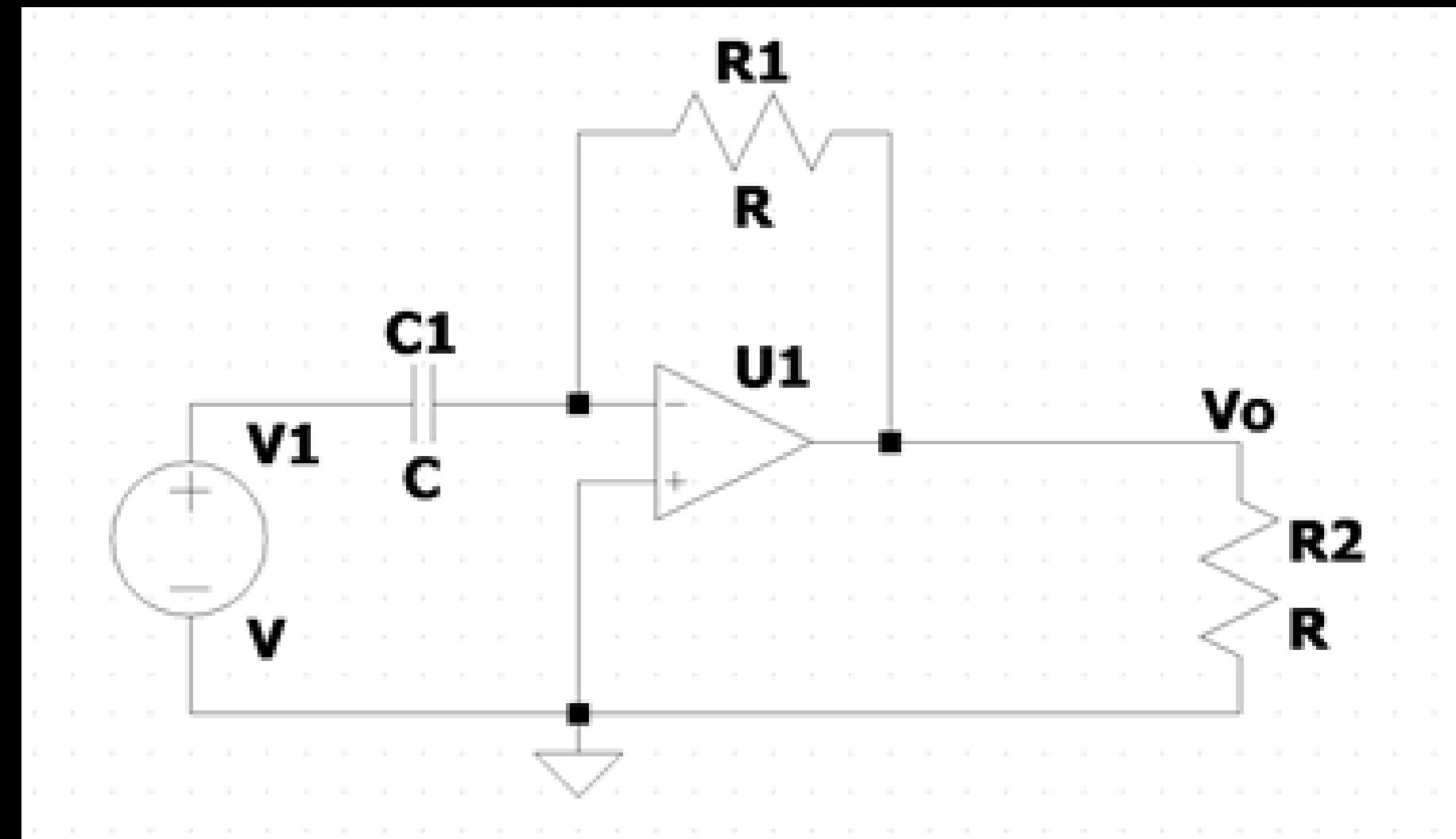
Input User:

- Resistansi resistor (Ω)
- Kapasitansi kapastor (F)
- Jenis gelombang tegangan input (sinus, cosinus, triangular, square wave)
- Periode gelombang input (s)
- Amplitudo gelombang input (Vp)

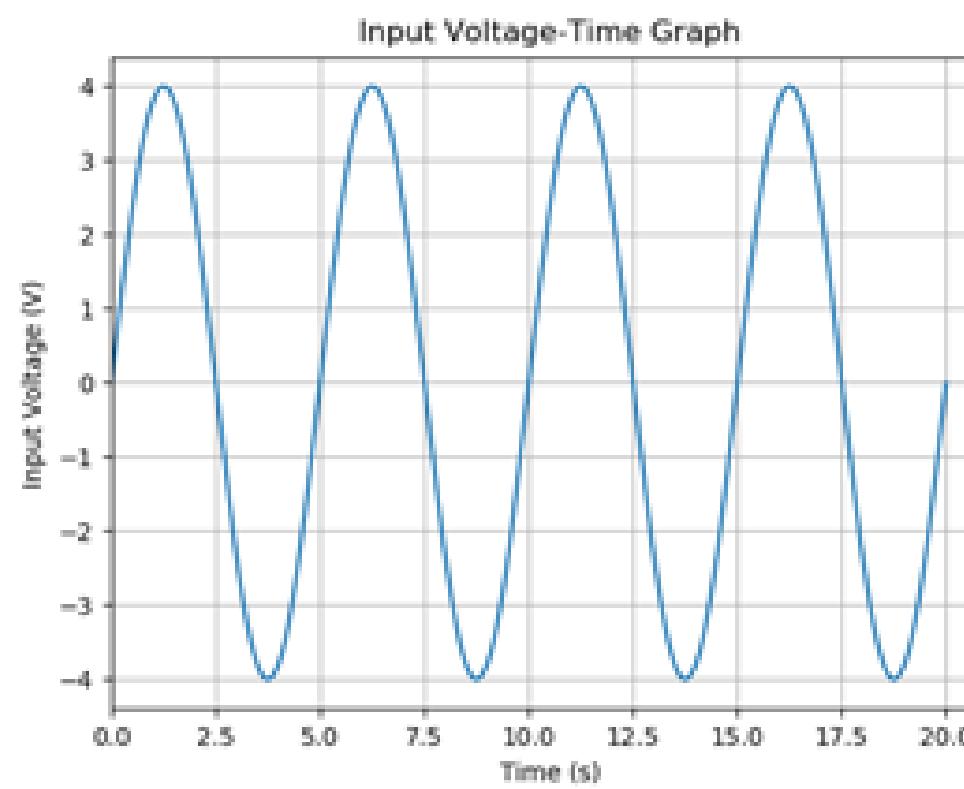
Output:

- Sinyal tegangan output (error<2%)
- Sinyal arus output (error<2%)

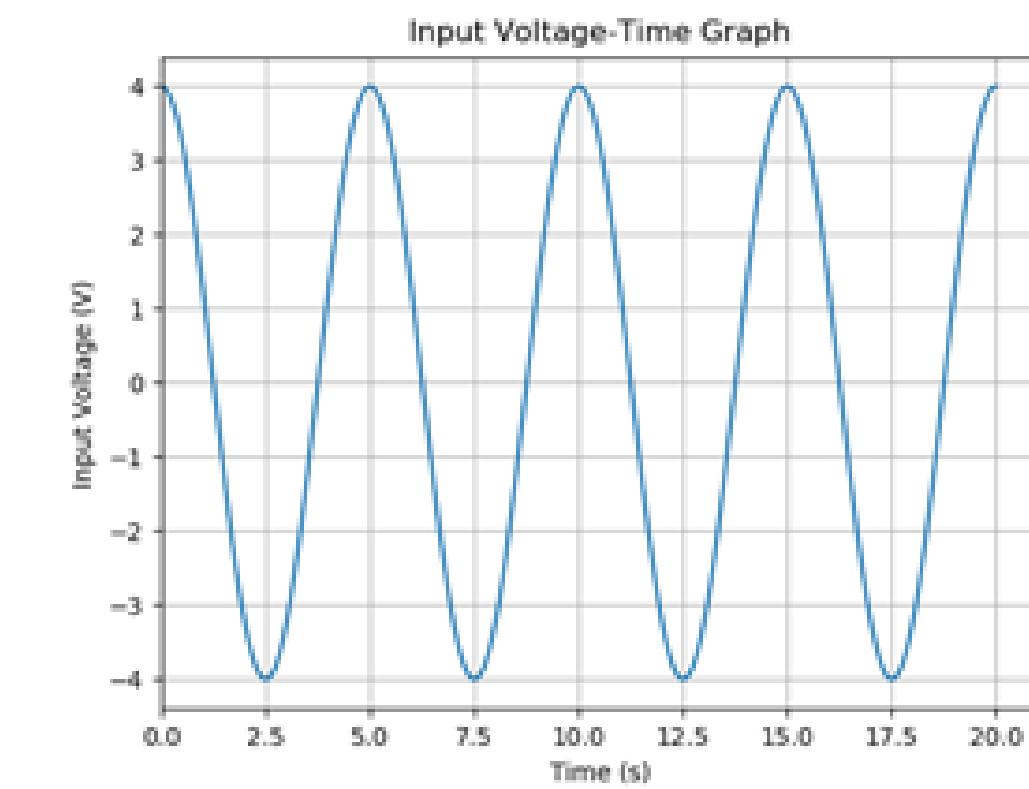
Rangkaian Differensiator



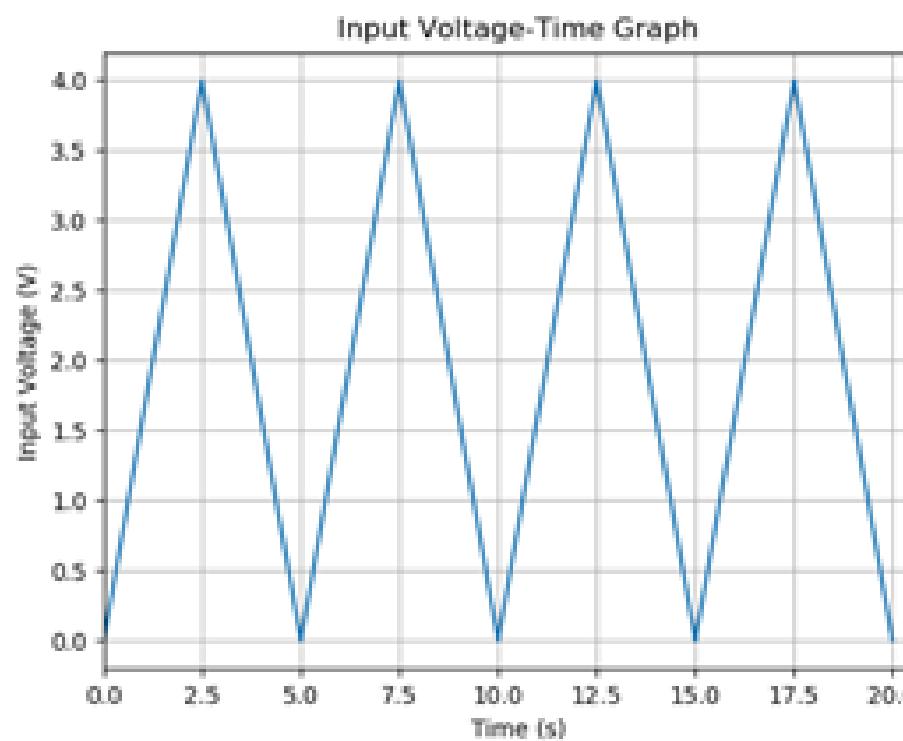
Jenis Gelombang Tegangan Input



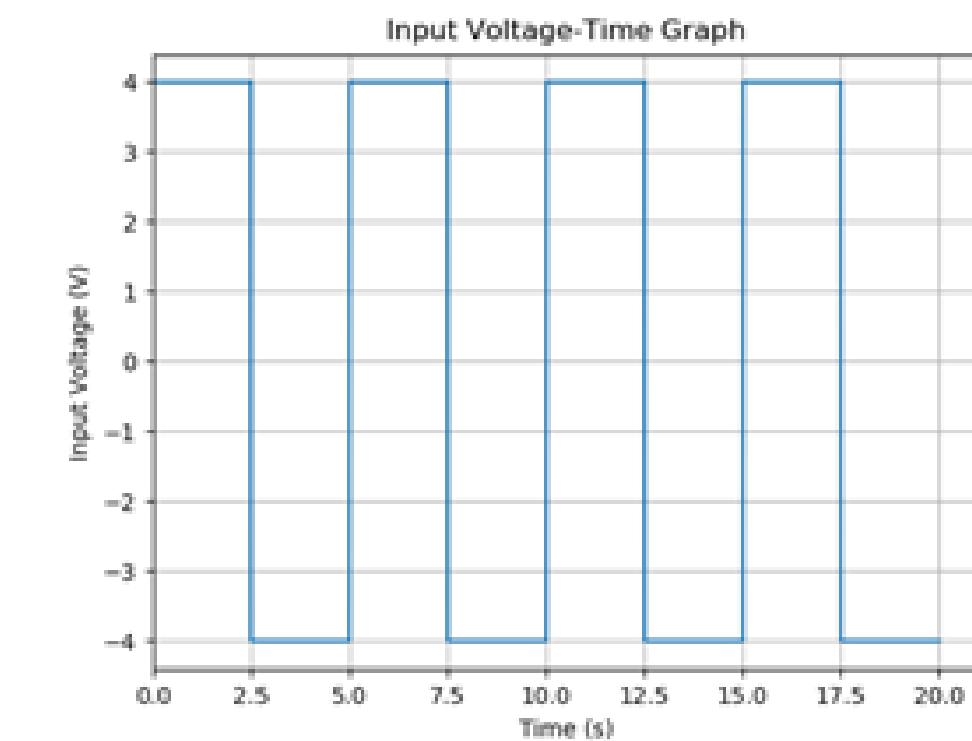
GELOMBANG SINUS



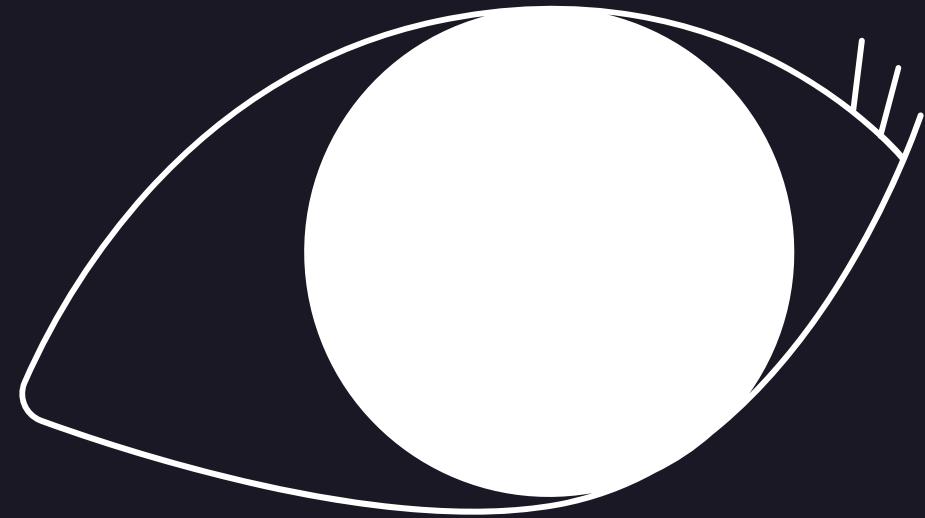
GELOMBANG COSINUS



GELOMBANG SEGITIGA



GELOMBANG KOTAK



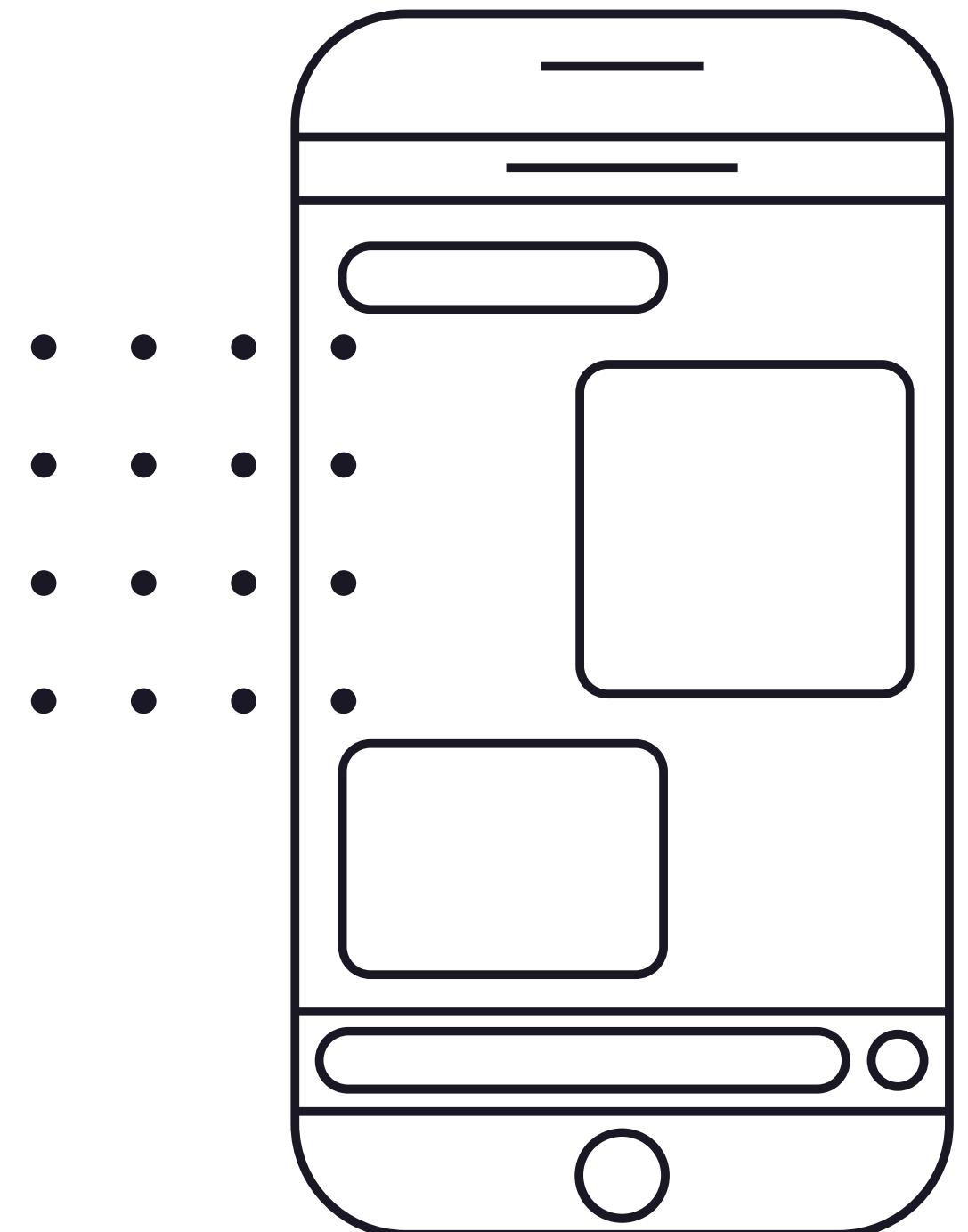
TAMPILAN GUI

GRAPHICAL USER INTERFACE (GUI)

TKINTER

Python 3.7

- Terdapat judul simulator dan keterangan
- Gambar 6 jenis rangkaian
- Gambar 4 jenis gelombang input rangkaian differensiator
- Terdapat dua buah form, yaitu untuk simulasi rangkaian RC dan rangkaian differensiator yang masing-masing terdiri dari 6 buah widget



RC AND DIFFERENTIATOR CIRCUIT SIMULATOR

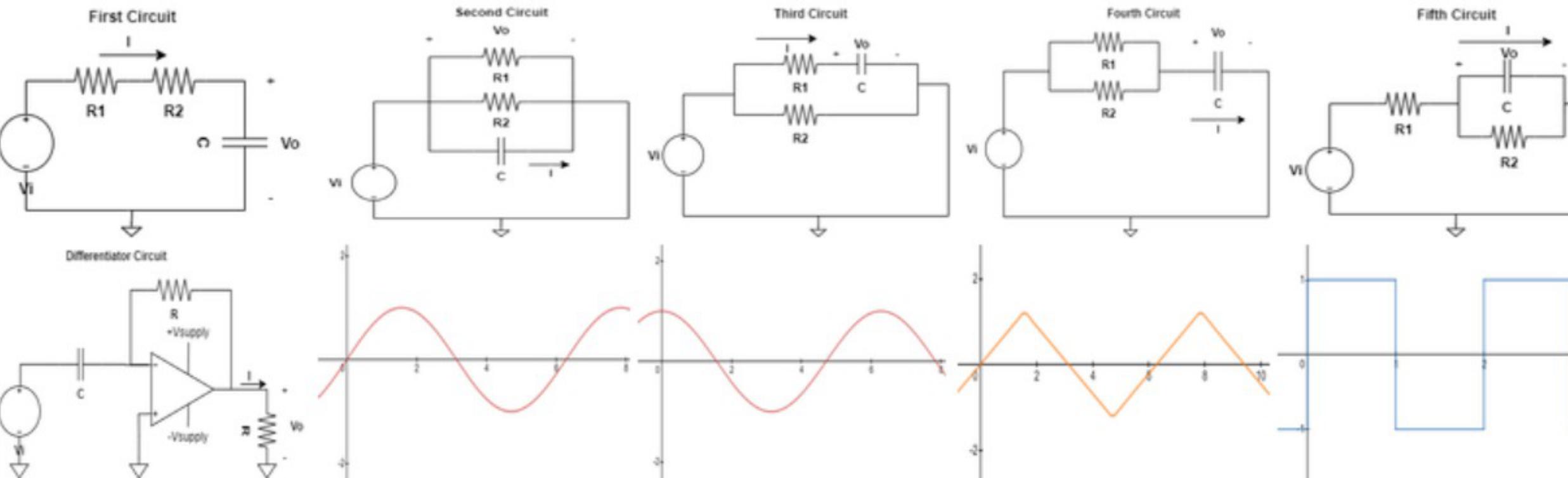
by Group 2 of EL2008

This simulator is a simulator for simulating RC circuits and first-order differentiator op-amp circuits.

The form on the left is the form to do RC simulation while the right form is to simulate the differentiator circuit.

To conduct a simulation, the user immediately fills in all the required data on each form then presses the submit button and the simulation will run.

Enjoy simulating!



RC Circuit

Circuit Type =

Output Variable =

V_i =

V

R_1 =

Ω

R_2 =

Ω

C =

F

Differentiator Circuit

Input Wave =

Variable =

Input Amplitude =

Period (T) =

R =

C =

DEMONSTRASI



— ERROR RANGKAIAN RC

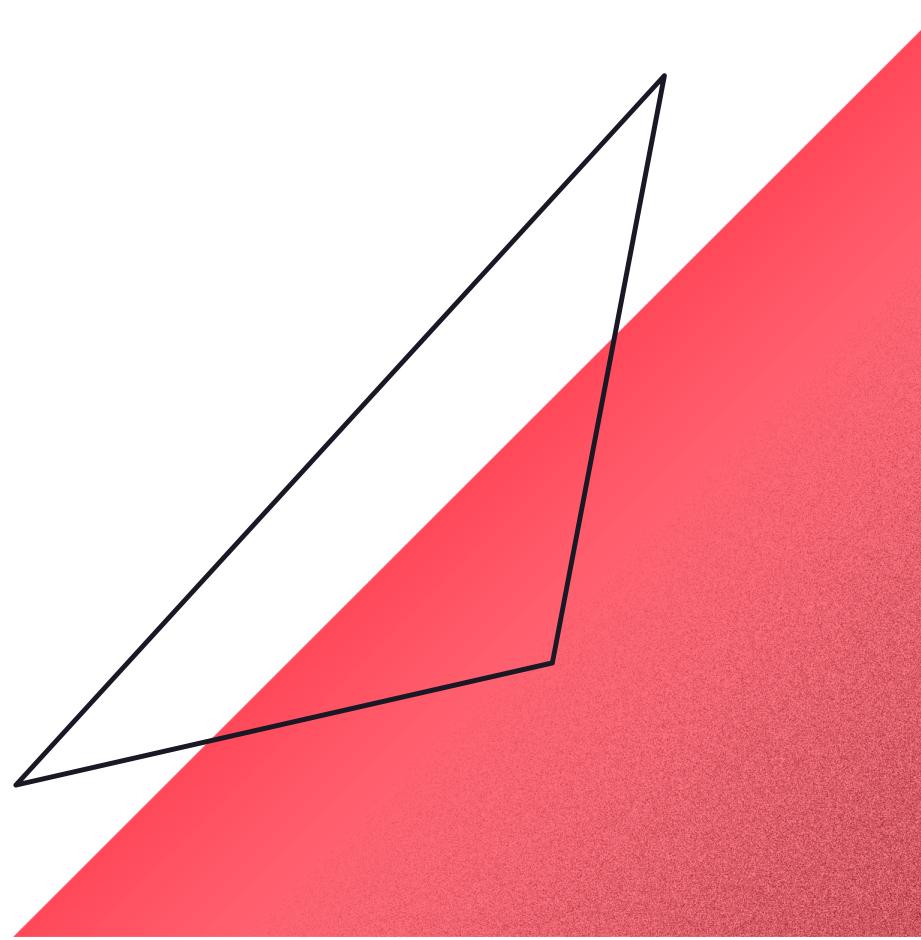
Jenis Rangkaian	Vi(V)	R1(Ω)	R2(Ω)	C(F)	Time constant	V Reference	V Simulation	I Reference	I Simulation	Error (%) V	Error (%) I	V Mean Error (%)	I Mean Error (%)	Mean Error (%)
1	5	1000	1000	470μ	0.94	3.1612017	3.159625	919.42087	920	0.049876602	0.062948913			
	8	1000	1100	150μ	0.315	5.0562529	5.052299	1.4017683	1.404	0.078198225	0.158952991	0.068219299	0.125372774	0.096796037
	12	1100	2200	100μ	0.33	7.5845745	7.578766	1.3379335	1.34	0.07658307	0.154216418			
2	5	1000	1000	470μ		5	5	0	0					
	8	1000	1100	150μ		8	8	0	0					
	12	1100	2200	100μ		12	12	0	0					
3	5	1000	1000	470μ	0.47	3.1601062	3.161014	1.8392723	1.839	0.028726883	0.01480696			
	8	1000	1100	150μ	0.15	5.0549437	5.057063	2.9450564	2.943	0.041925294	0.069874278	0.02710223	0.043098746	0.035100488
	12	1100	2200	100μ	0.11	7.5864553	7.585647	4.0112096	4.013	0.010654515	0.044615001			
4	5	1000	1000	470μ	0.235	3.1597118	3.156696	3.6805764	3.687	0.095445414	0.174222945			
	8	1000	1100	150μ	0.0786	5.0583692	5.054344	5.6158409	5.695	0.079575054	1.389975417	0.093101901	0.58228357	0.337692736
	12	1100	2200	100μ	0.0733	7.5875553	7.595468	6.0169701	6.006	0.104285237	0.182652348			
5	5	1000	1000	470μ	0.235	1.5802165	1.578348	1.8395669	1.843	0.118243291	0.186277808			
	8	1000	1100	150μ	0.0786	2.651091	2.647513	2.9388261	2.946	0.134963304	0.243513238	0.109575011	0.187645134	0.148610073
	12	1100	2200	100μ	0.0733	5.0598239	5.063645	4.0093311	4.004	0.075518438	0.133144356			
Mean RC Circuit Simulator Error (%)														0.15454983

*Catatan: Rangkaian 2 mempunyai nilai tegangan output yang selalu sama dengan input (satu node)

— ERROR RANGKAIAN DIFFERENSIATOR

Gelombang Input	A (V)	T (s)	R (Ω)	C (μF)	t (s)	Vo Referensi (V)	Vo Simulator (mV)	Error (%)
Sinus	4	5	1000	100	1	-0.15329274	-0.155329	1.328347
	5	4	5000	150	3.5	-4.2155662	-4.165202	1.19472
	10	2	2200	470	11.2	25.988296	26.280642	1.124914
Cosinus	4	5	1000	100	1	0.47000232	0.478053	1.712902
	5	4	5000	150	3.5	-4.1147932	-4.165202	1.225063
	10	2	2200	470	11.2	-19.37321	-19.093985	1.441294
Segitiga	4	5	1000	100	1	-0.15993147	-0.16	0.04285
	5	4	5000	150	3.5	1.8751499	1.875	0.007994
	10	2	2200	470	11.2	10.349947	10.340001	0.096097
Kotak	4	5	1000	100	4.5	0	0	0
	5	4	5000	150	3	0	0	0
	10	2	2200	470	1	0	0	0
Error Simulator Differentiator (%)								0.90824

*Catatan: Perhitungan error untuk sinyal input gelombang kotak tidak diperhitungkan karena pada setiap waktu, nilainya akan bernilai nol, kecuali terdapat impuls pada waktu tertentu

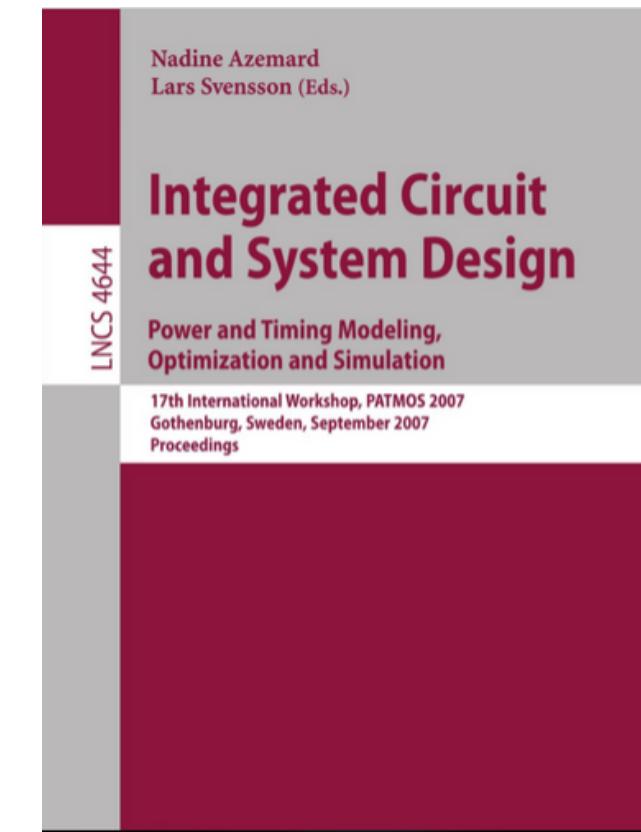


MAKSIMUM ERROR

Berdasarkan buku *Integrated Circuit and System Design. Power and Timing Modeling*, terlihat bahwa maksimum error untuk suatu simulator rangkaian adalah 2%.

5 Evaluation

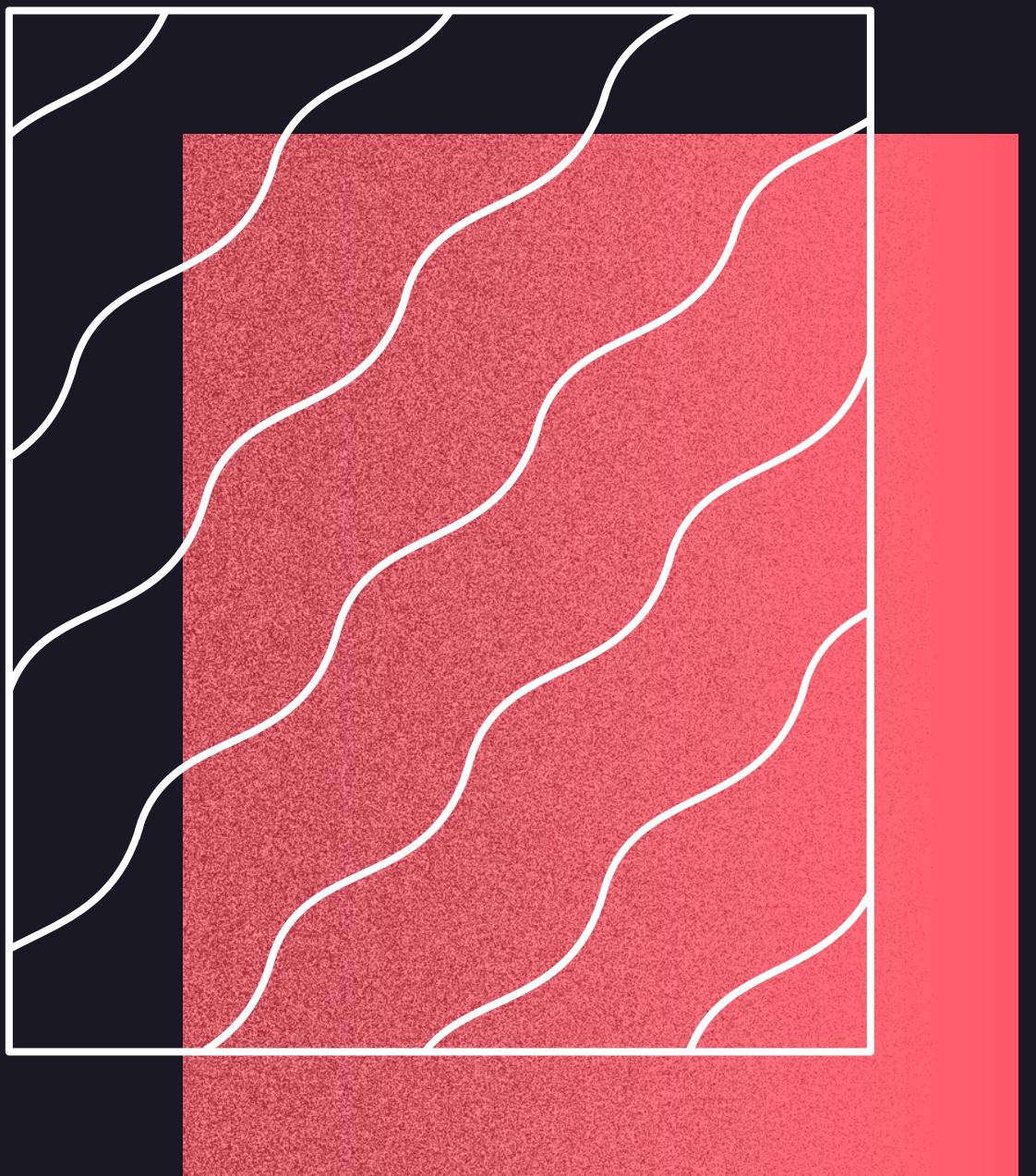
The evaluation results are obtained, comparing the modeled delay against simulations at transistor level. Therefore, the SPICE simulator combined with the transistor model BSIM4.50 was used. The whole characterization of our model has been done for a 90nm technology. The analyzed RT components have been synthesized using a commercial synthesis tool. For each component, we extracted the critical path and limited simulation to it, to ensure having maximum delay. Table 2 holds the ranges and the count of samples for each dimension of the reference inverters sample field. Interpolation between the samples causes a maximum error of 2% with a standard deviation of 0.1%.





KESIMPULAN

- Aplikasi simulator dapat dirancang dan diimplementasikan dengan baik
- Simulator dapat melakukan simulasi 5 jenis rangkaian RC dan rangkaian differensiator
- Hasil unit test dan functional test sesuai dengan ekspektasi
- Hasil aplikasi sesuai dengan hasil simulasi LTspice (dengan error rata-raya sebesar 0.155% untuk rangkaian RC dan error rata-rata sebesar 0.908% untuk rangkaian differensiator)

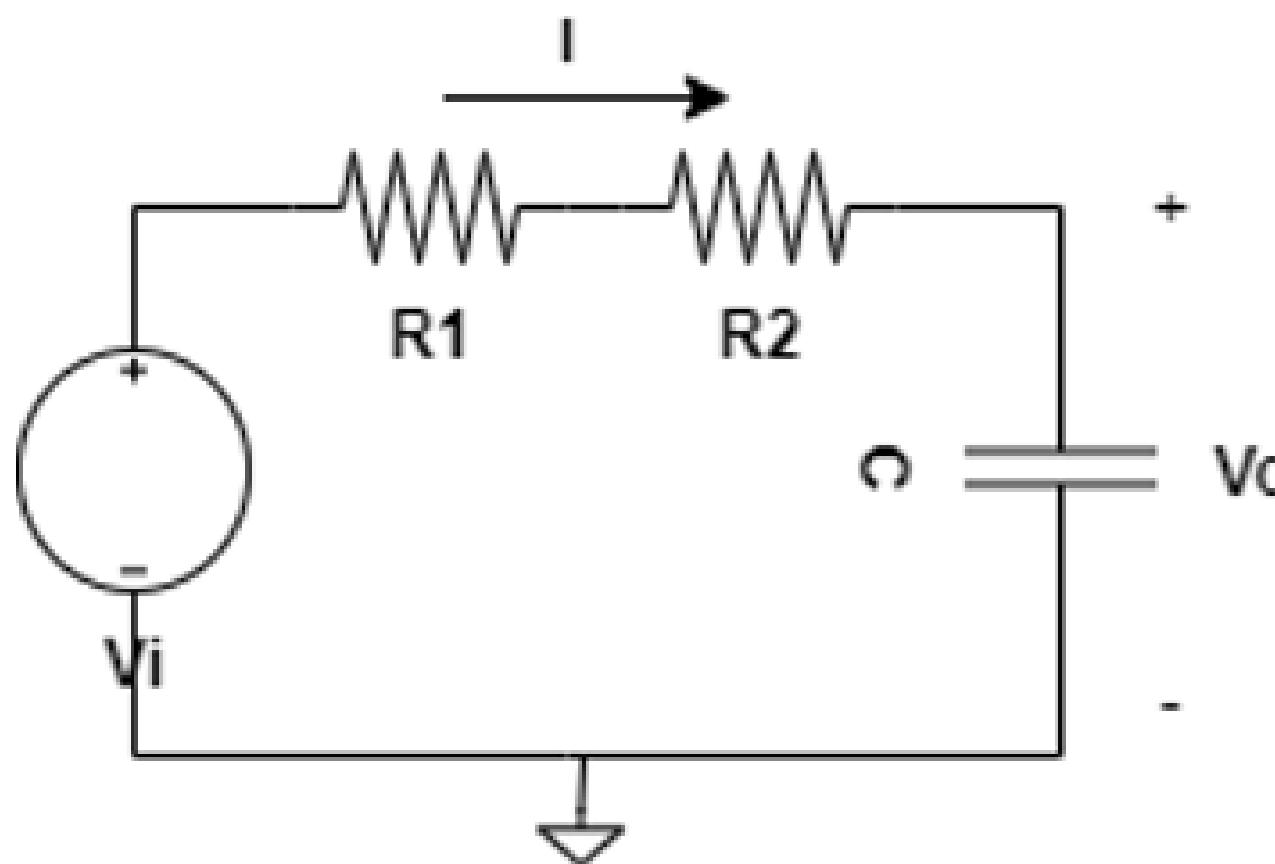


APPENDIX



ANALISIS PERHITUNGAN RANGKAIAN RC T1PE 01

First Circuit



$$\sum_{n=1}^n V_n = 0$$

$$-V_s + V_{R1} + V_{R2} + V_o = 0$$

$$V_o = V_s - V_{R1} - V_{R2}$$

$$V_o = V_s - i(R_1 + R_2) \quad (\text{pers. 1})$$

$$i = C \frac{dv}{dt} \quad (\text{pers. 2})$$

Pada kapasitor yang diberi tegangan DC, arus yang mengalir pada kapasitor dapat didekati dengan hubungan pada persamaan 2 dan karena resistor dan kapasitor disusun seri, arus di kedua komponen tersebut sama sehingga:

$$V_o = V_s - (R_1 + R_2)C \frac{dv}{dt}$$

Dengan τ merupakan konstanta waktu yang bernilai RC , maka:

$$\tau = (R_1 + R_2)C$$

$$V_o = V_s - \tau \frac{dv}{dt} \quad (\text{pers. 3})$$

dv atau perubahan nilai tegangan dapat didekati dengan :

$$dv = V_o(t) - V_o(t-1) \quad (\text{pers. 4})$$

Dengan mensubstitusikan pers. 4 ke pers. 3, didapat:

$$V_o(t) = V_s - \tau \frac{V_o(t) - V_o(t-1)}{dt}$$

$$V_o(t)dt = V_s - \tau[V_o(t) - V_o(t-1)]$$

$$V_o(t)[dt + \tau] = Vsdt - V_o(t-1)\tau$$

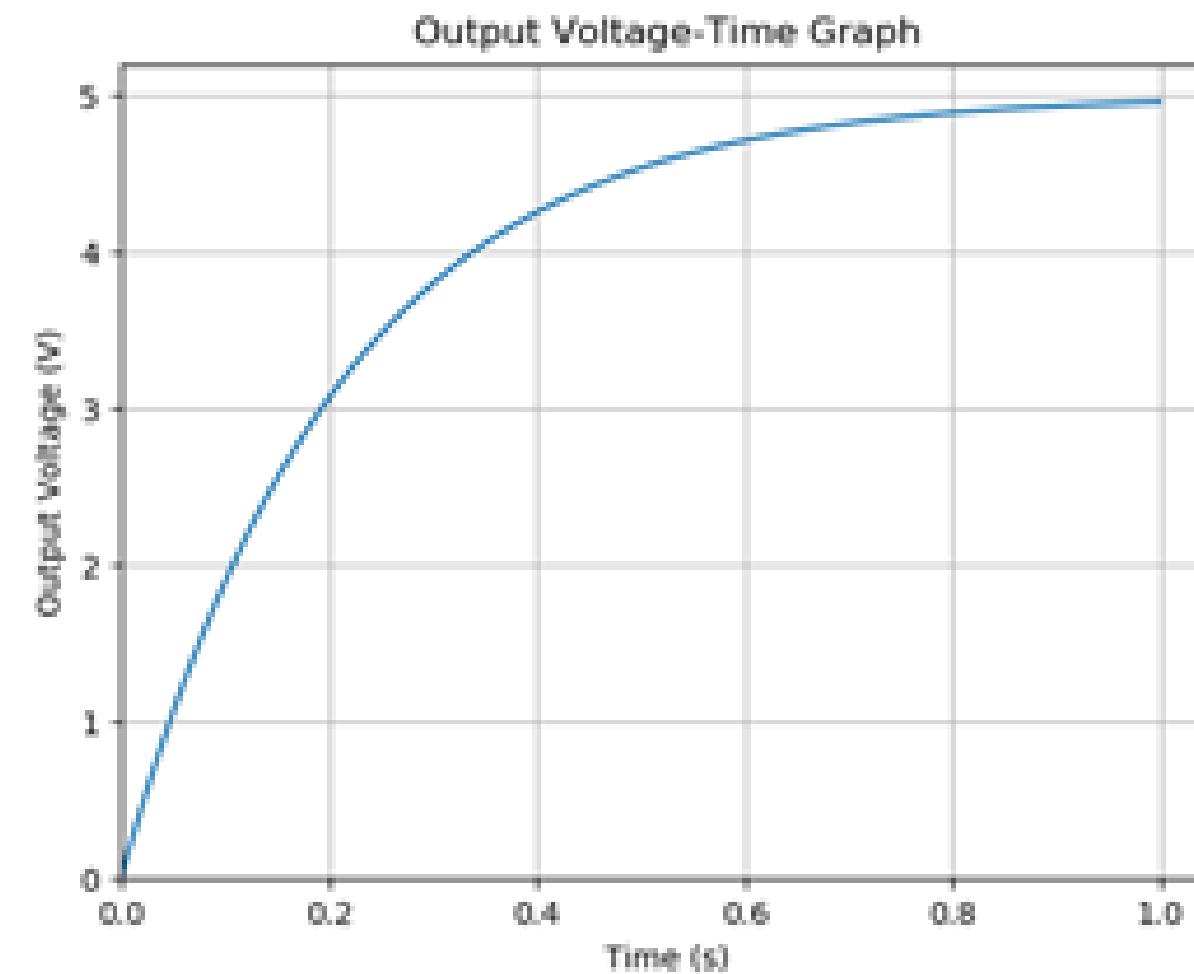
$$V_o(t) = \frac{Vsdt + V_o(t-1)\tau}{dt + \tau} \quad (\text{pers. 5})$$

Persamaan Tegangan Output pada Rangkaian RC Tipe 1

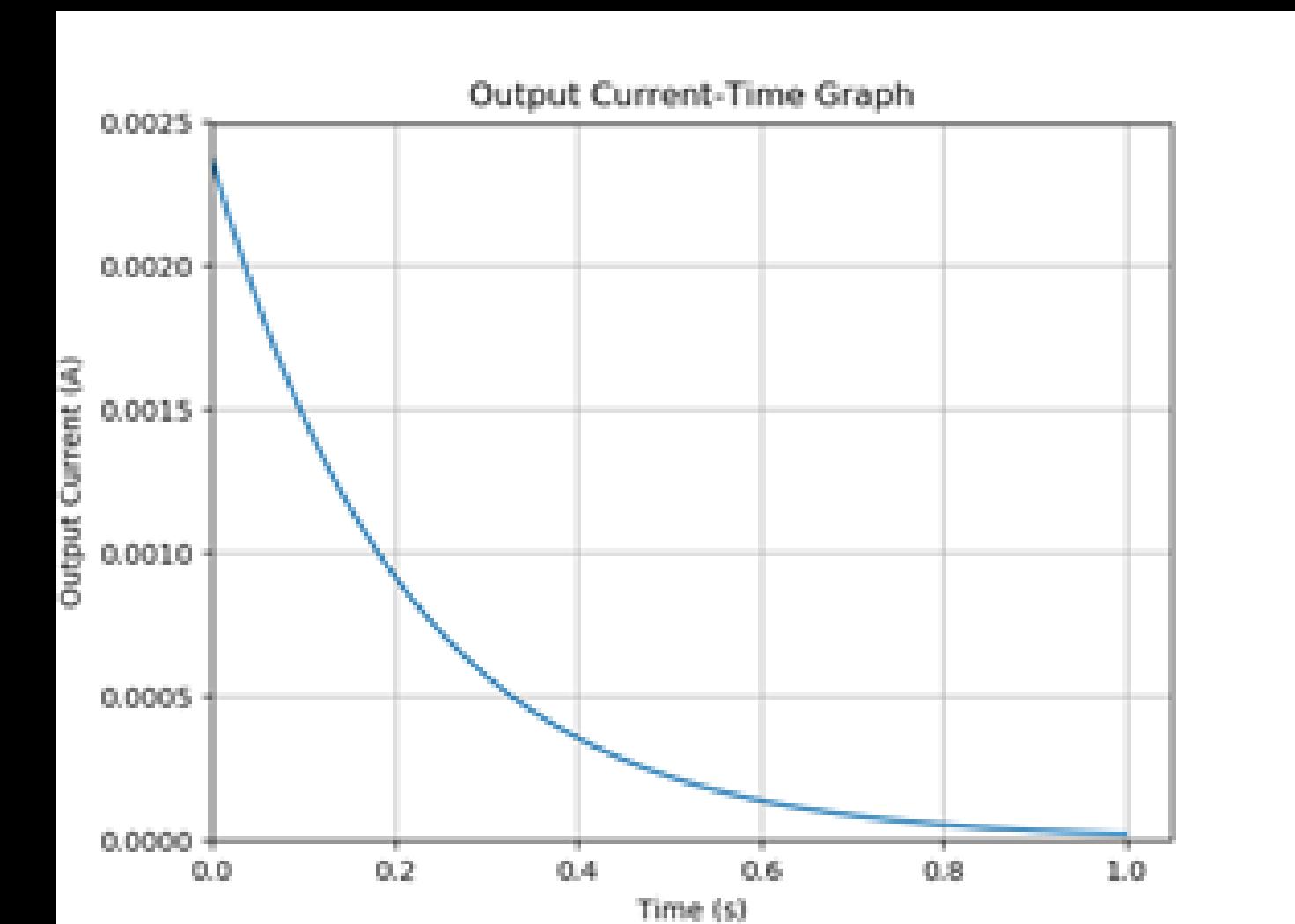
$$I = \frac{V_i - V_o}{R_1 + R_2}$$

Persamaan Arus Output pada Rangkaian RC Tipe 1

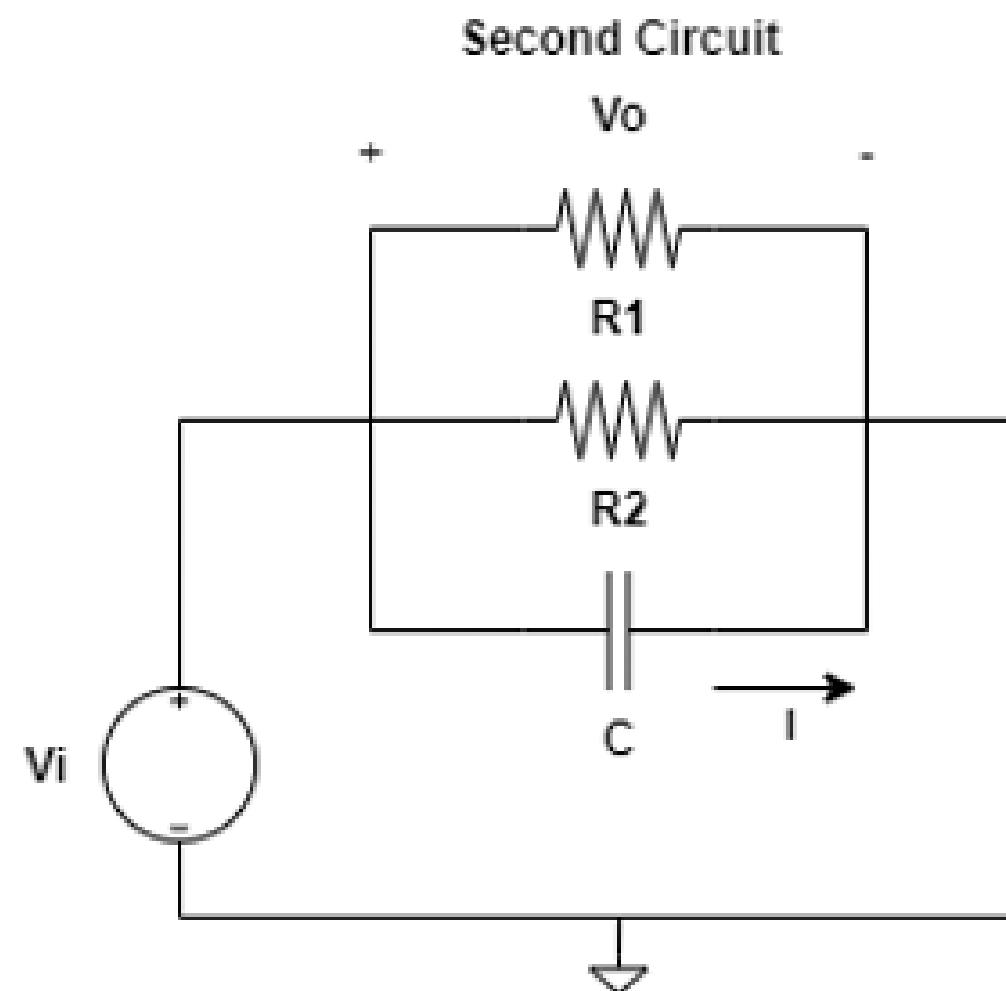
Output Tegangan



Output Arus



ANALISIS PERHITUNGAN RANGKAIAN RC T1PE 02



Berikut ini kondisi tersebut dalam bentuk persamaan:

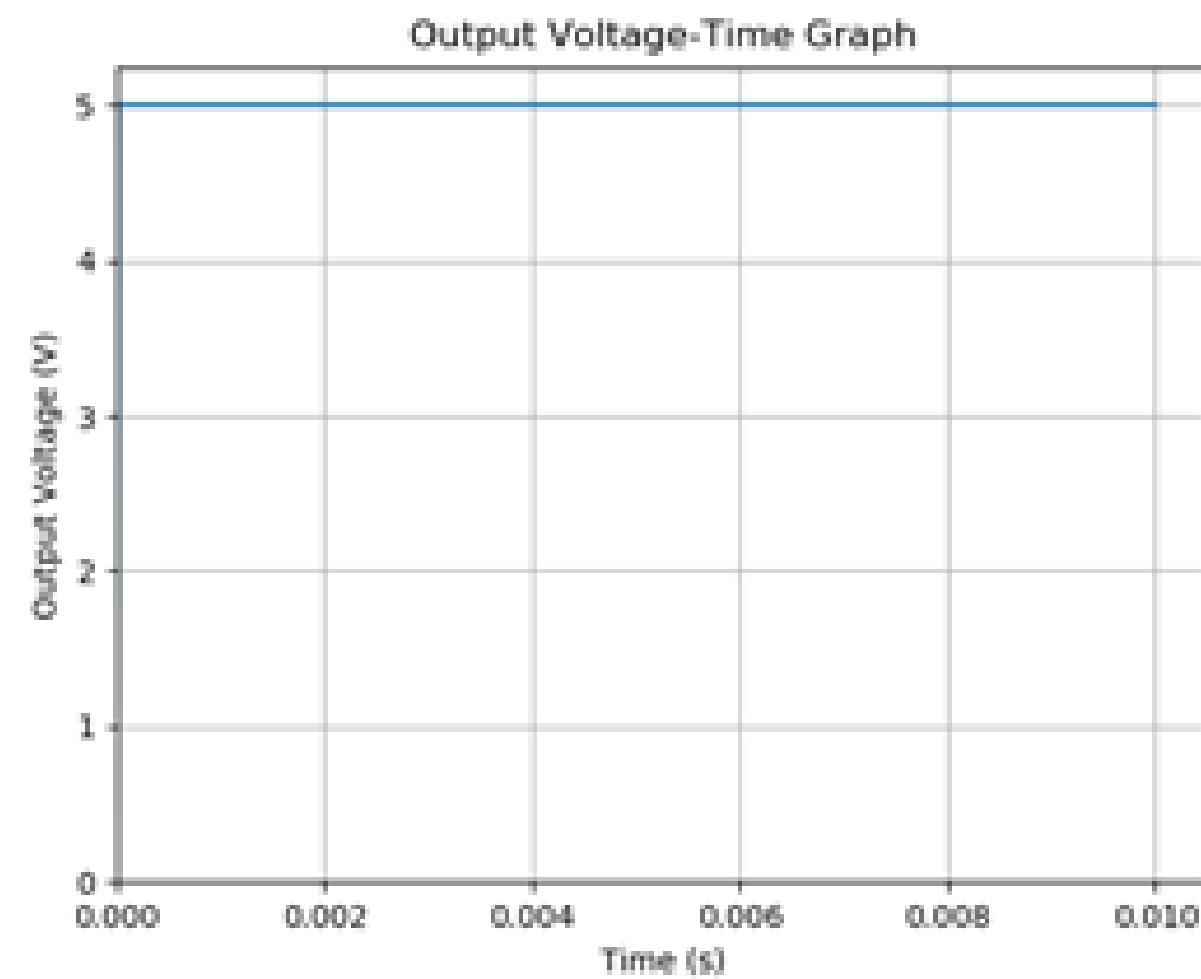
$$V_o = V_i$$

Persamaan Hubungan Tegangan Output dengan Tegangan Input pada Rangkaian Tipe 2

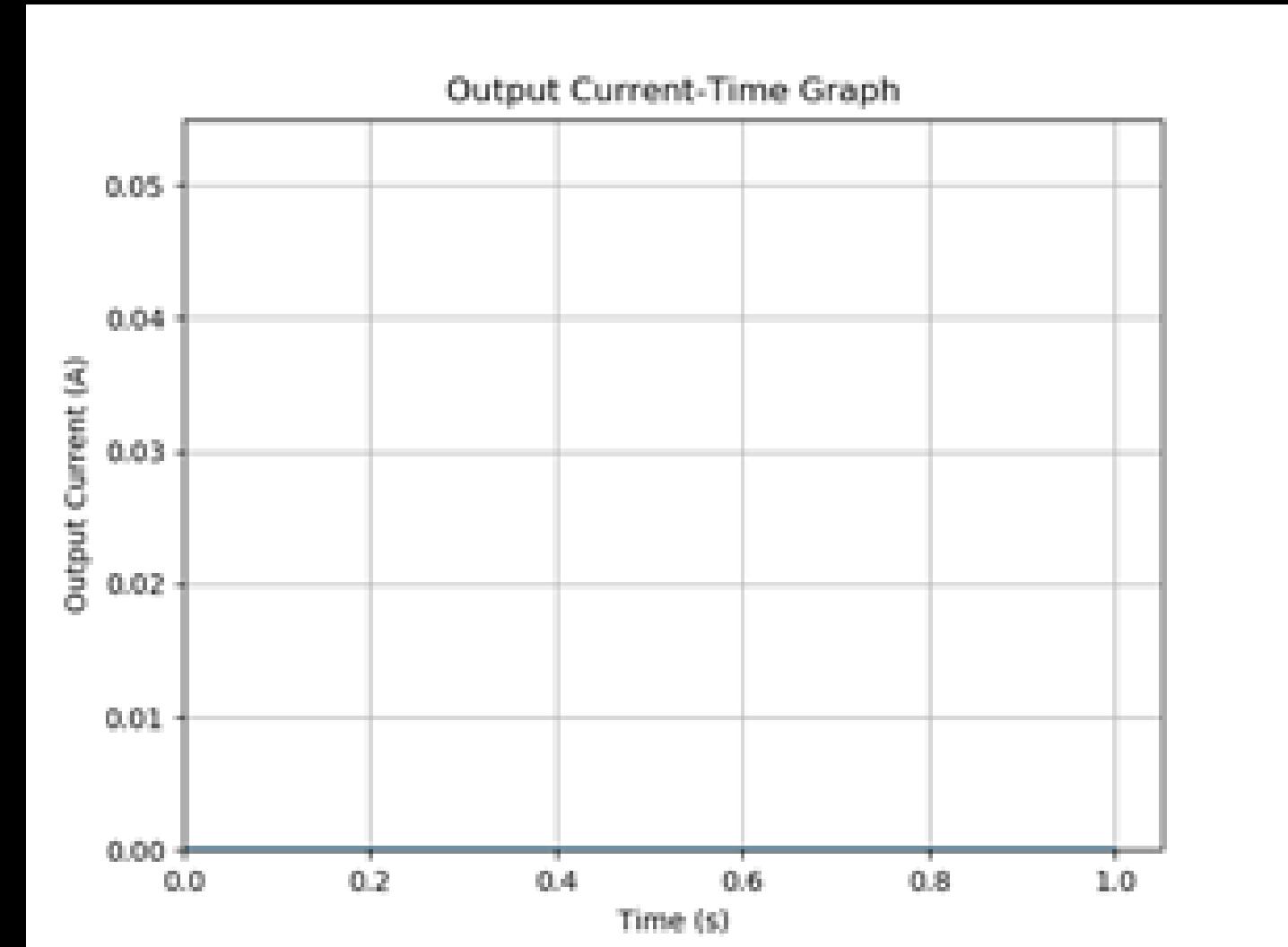
$$I_o = 0$$

Persamaan Arus Output pada Rangkaian Tipe 2

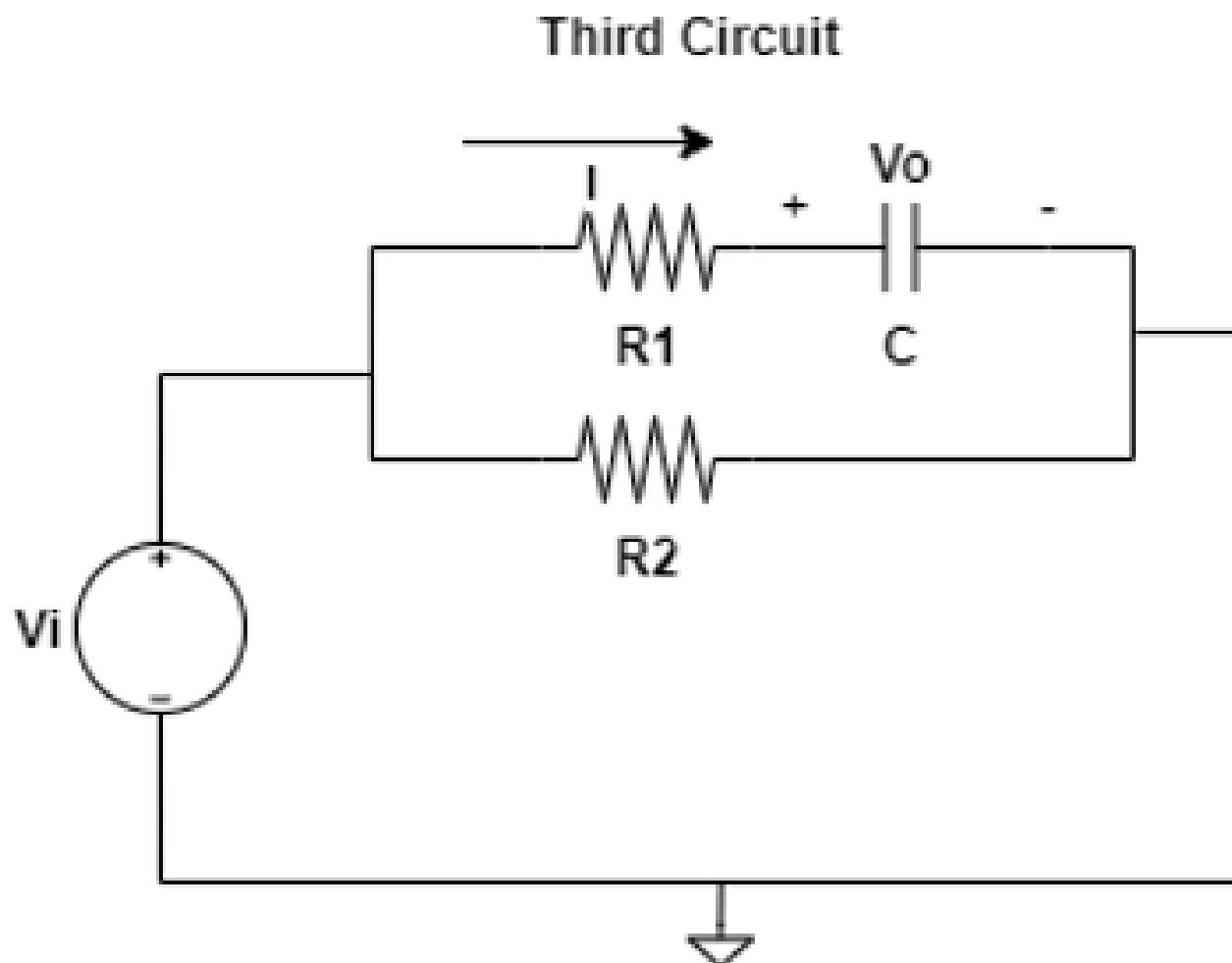
Output Tegangan



Output Arus



ANALISIS PERHITUNGAN RANGKAIAN RC TIPE 03



Arus pada kapasitor memenuhi:

$$I_C = C \frac{d V_C}{dt}$$

Dengan menggunakan analisis nodal, arus yang melalui kapasitor adalah:

$$I_C = \frac{V_{R1} - V_C}{R_1}$$

Karena rangkaian bersifat paralel, V_{R1} akan sama dengan V_{in} , sehingga

$$I_C = \frac{V_{in} - V_C}{R_1}$$

Persamaan Arus Output pada Rangkaian Tipe 3

Maka, Tegangan keluaran rangkaian adalah :

$$I_C = C \frac{d V_C}{dt}$$

$$I_C = \frac{V_{in} - V_C}{R_1}$$

$$C \frac{d V_C}{dt} = \frac{V_{in} - V_C}{R_1}$$

$$d V_C = \frac{(V_{in} - V_C)}{R_1 \cdot C} dt$$

$$d V_C = \frac{(V_{in} - V_C)}{R_1 \cdot C} dt$$

$$d V_C = V_C(t) - V_C(t - 1)$$

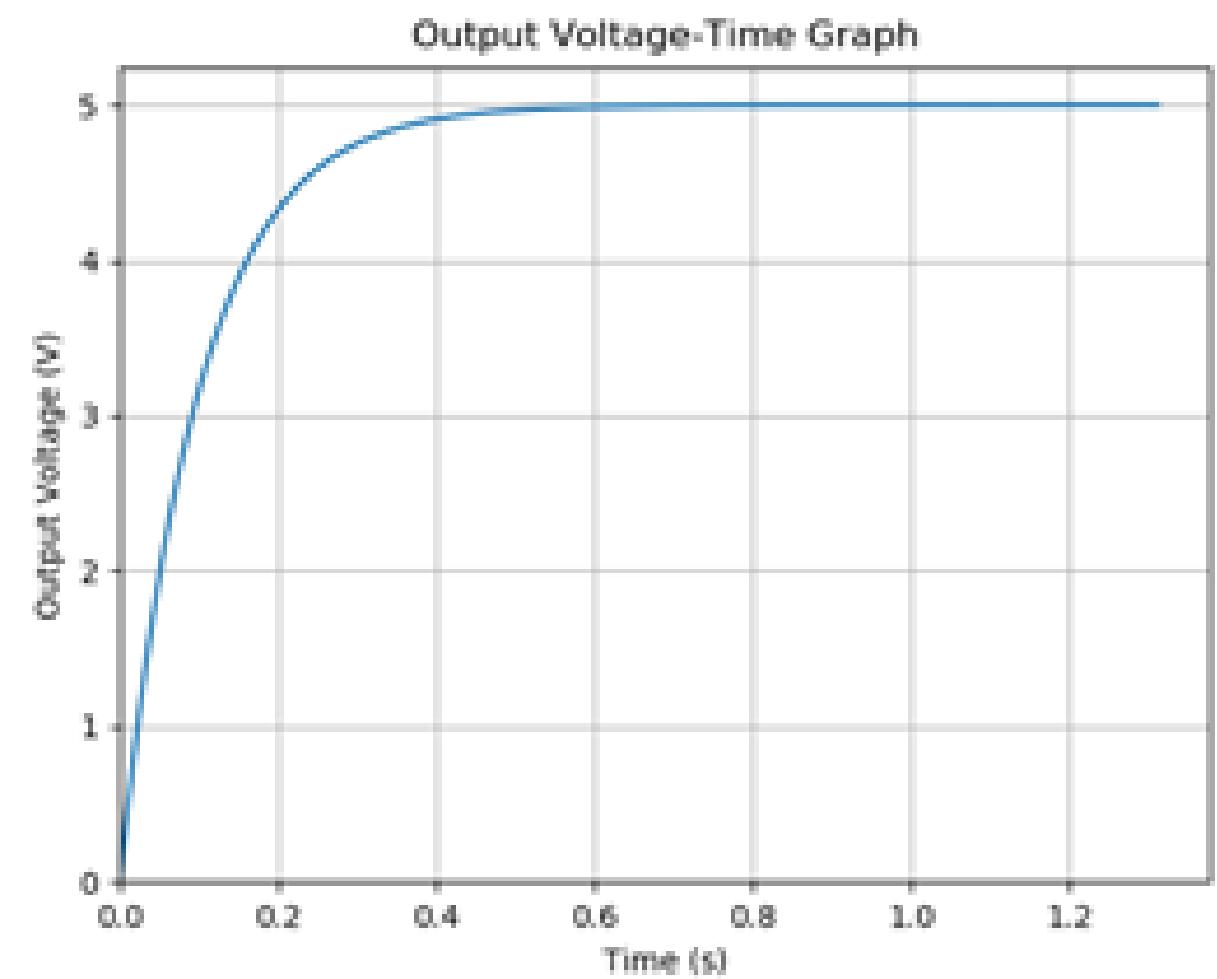
$$\frac{V_C(t) - V_C(t - 1)}{dt} = \frac{V_{in} - V_C(t)}{R_1 \cdot C}$$

$$V_C(t) = \frac{V_C(t - 1)(R_1 \cdot C) + V_{in} * dt}{R_1 \cdot C + dt}$$

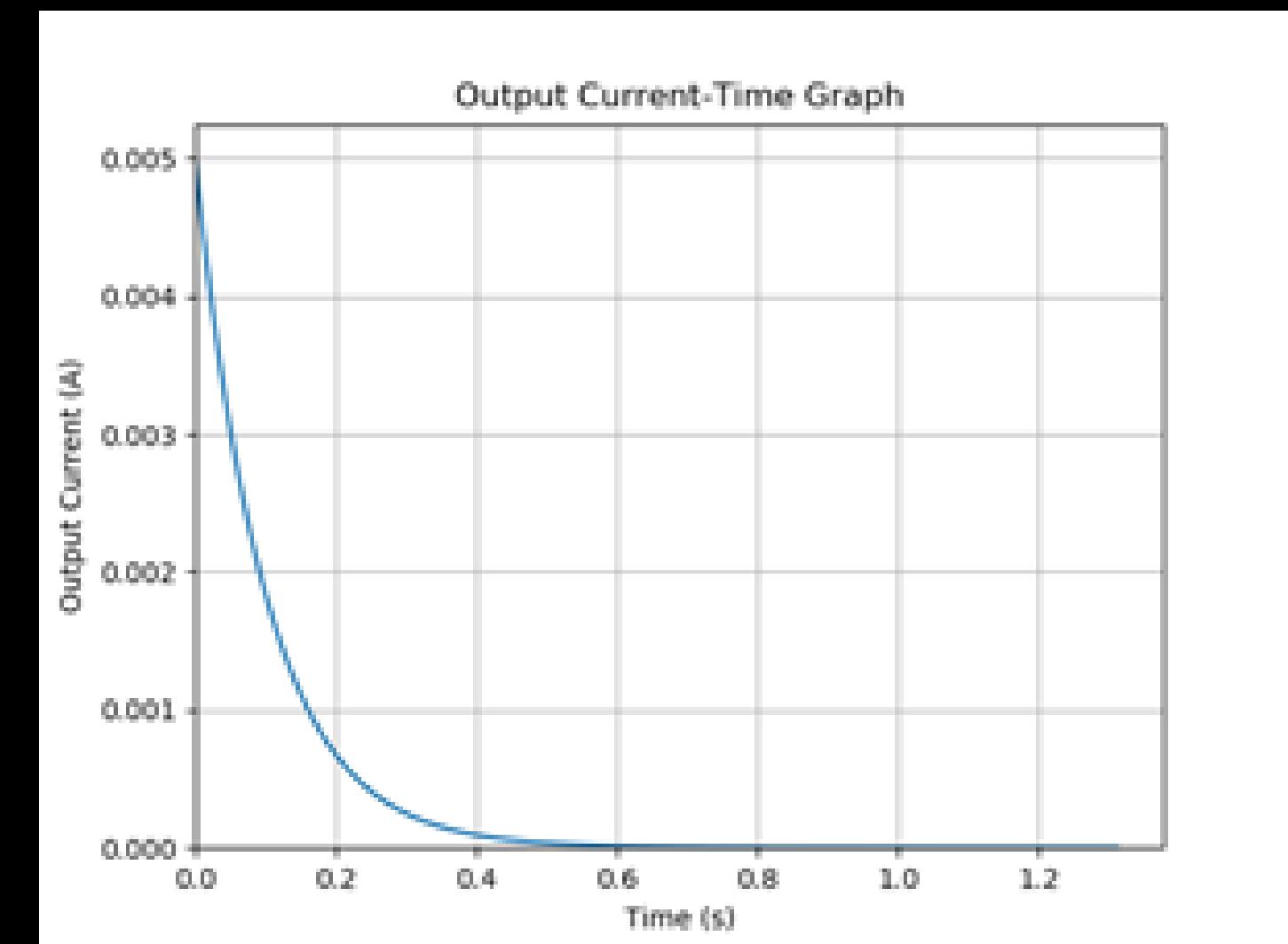
Persamaan Tegangan Output pada Rangkaian Tipe 3

$$\text{Sehingga, } V_o(t) = V_C(t) = \frac{V_C(t-1)(R_1 \cdot C) + V_{in} * dt}{R_1 \cdot C + dt}$$

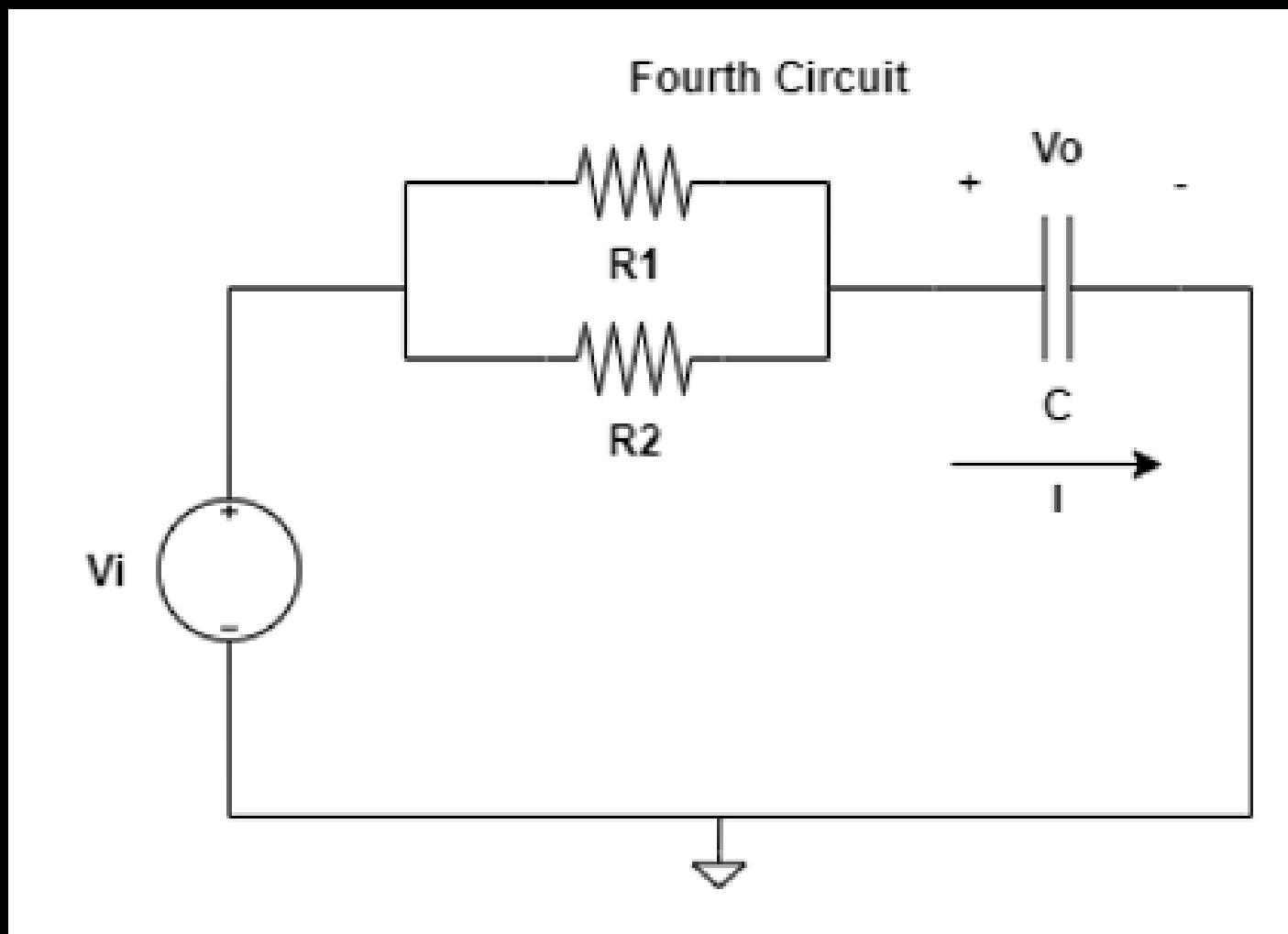
Output Tegangan



Output Arus



ANALISIS PERHITUNGAN RANGKAIAN RC TIPE 04



$$I_c = C \frac{dV_c}{dt}$$

Dilakukan KVL pada rangkaian:

$$-V_i + (R_1//R_2) I_c + V_c = 0$$

$$(R_1//R_2) I_c = V_i - V_c$$

$$I_c = \frac{V_i - V_c}{R_1//R_2}$$

Persamaan Arus Output pada Rangkaian 4

Samakan kedua persamaan diatas:

$$C \frac{dV_c}{dt} = \frac{V_i - V_c}{R_1//R_2}$$

$$\frac{dV_c}{dt} = \frac{V_i - V_c}{C(R_1//R_2)}$$

Dapat diketahui bahwa $V_c = V_o$

$$\frac{dV_o}{dt} = \frac{V_i - V_o}{C(R_1//R_2)}$$

Dengan dV_o dapat didekati dengan $V_o(t) - V_o(t - 1)$

$$\frac{V_o(t) - V_o(t - 1)}{dt} = \frac{V_i - V_o(t)}{C(R_1//R_2)}$$

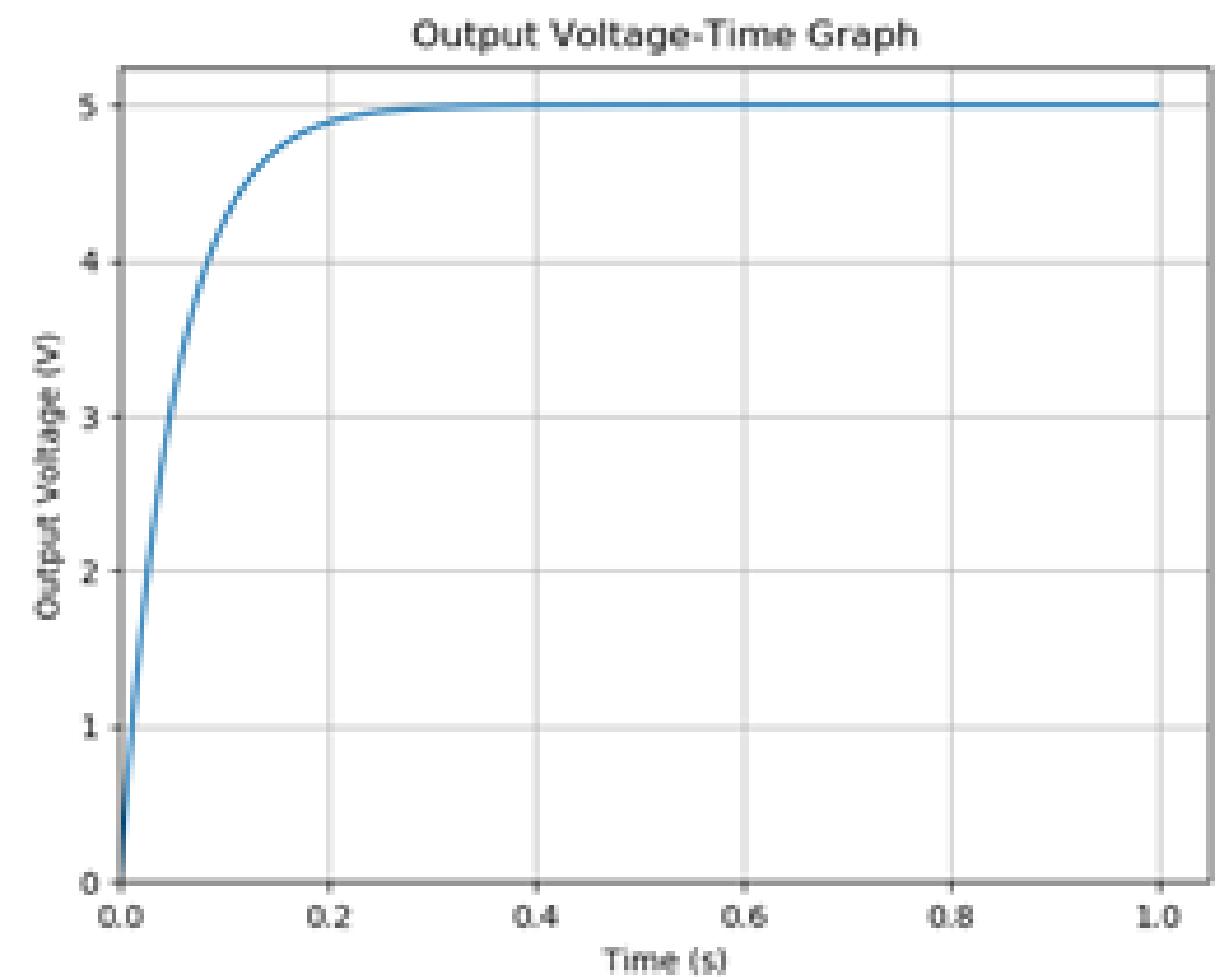
$$C(R_1//R_2) [V_o(t) - V_o(t - 1)] = dt (V_i - V_o(t))$$

$$V_o(t) [C(R_1//R_2) + dt] = V_i \cdot dt + V_o(t - 1) [C(R_1//R_2)]$$

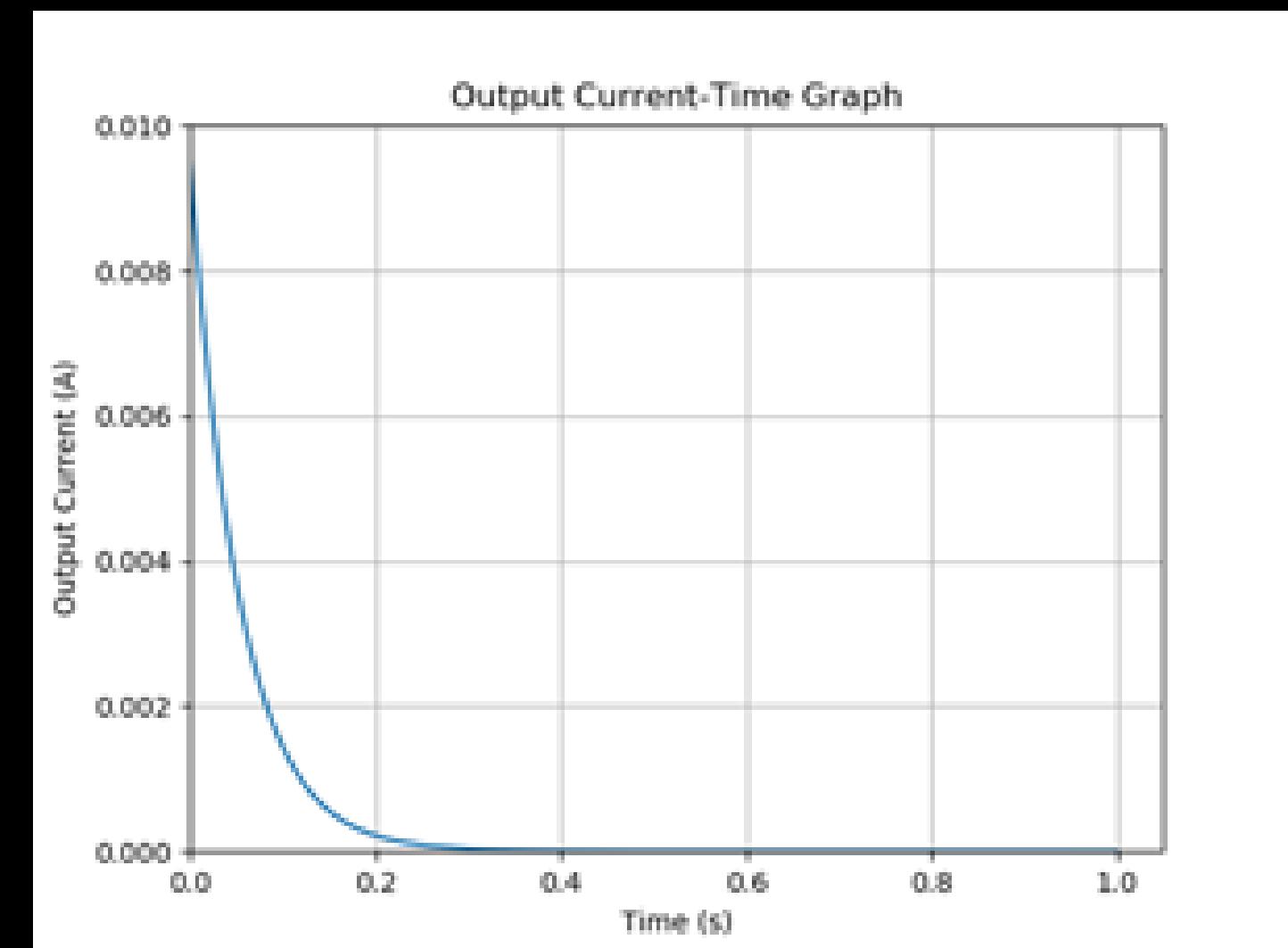
$$V_o(t) = \frac{V_i \cdot dt + V_o(t - 1) [C(R_1//R_2)]}{C(R_1//R_2) + dt}$$

Persamaan Tegangan Output pada Rangkaian RC Tipe 4

Output Tegangan

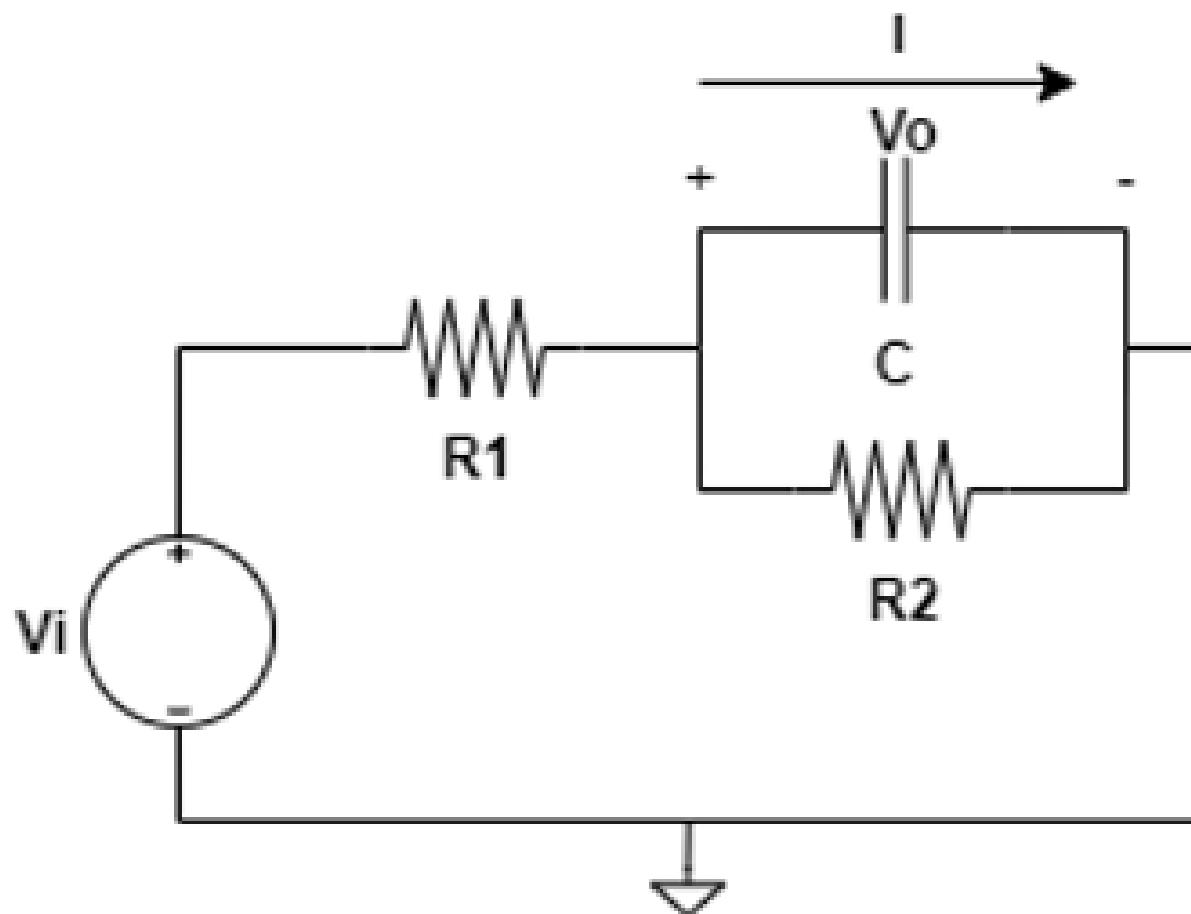


Output Arus



ANALISIS PERHITUNGAN RANGKAIAN RC T1PE 05

Fifth Circuit



dengan *nodal analysis*:

$$\frac{V_o - V_i}{R_1} + \frac{V_o}{R_2} + C \frac{dV_i}{dt} = 0$$

$$\frac{V_o - V_i}{R_1} + \frac{V_o}{R_2} + C \frac{V_o(i) - V_o(i-1)}{dt} = 0$$

$$V_o \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{C}{dt} \right) = C \frac{V_o(i-1)}{dt} + \frac{V_i}{R_1}$$

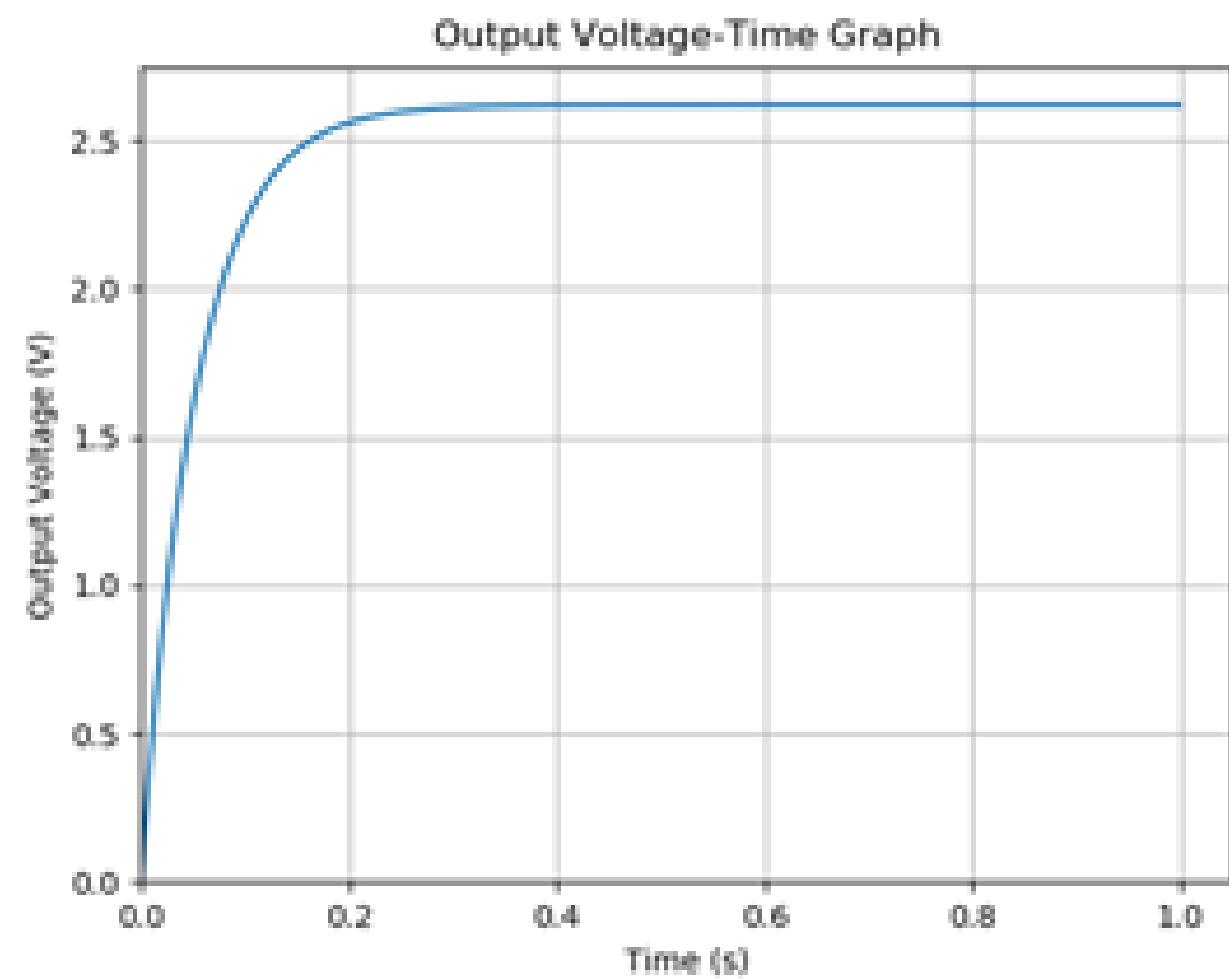
$$V_o = \frac{\left(C \frac{V_o(i-1)}{dt} + \frac{V_i}{R_1} \right)}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{C}{dt}}$$

Persamaan Tegangan Output Rangkaian Tipe 5

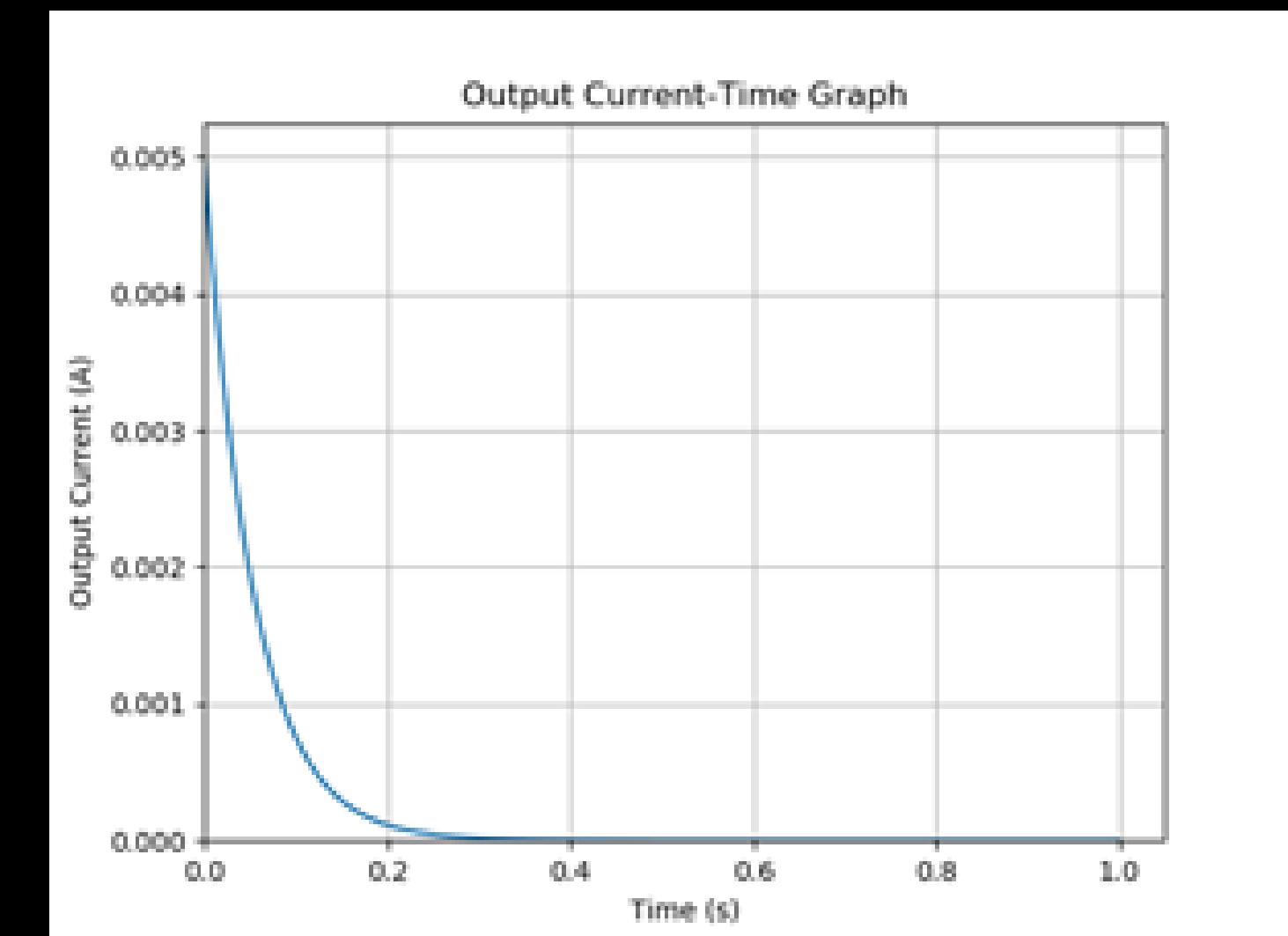
$$I_o = C \frac{dV_o}{dt}$$

Persamaan Arus Output Rangkaian 5

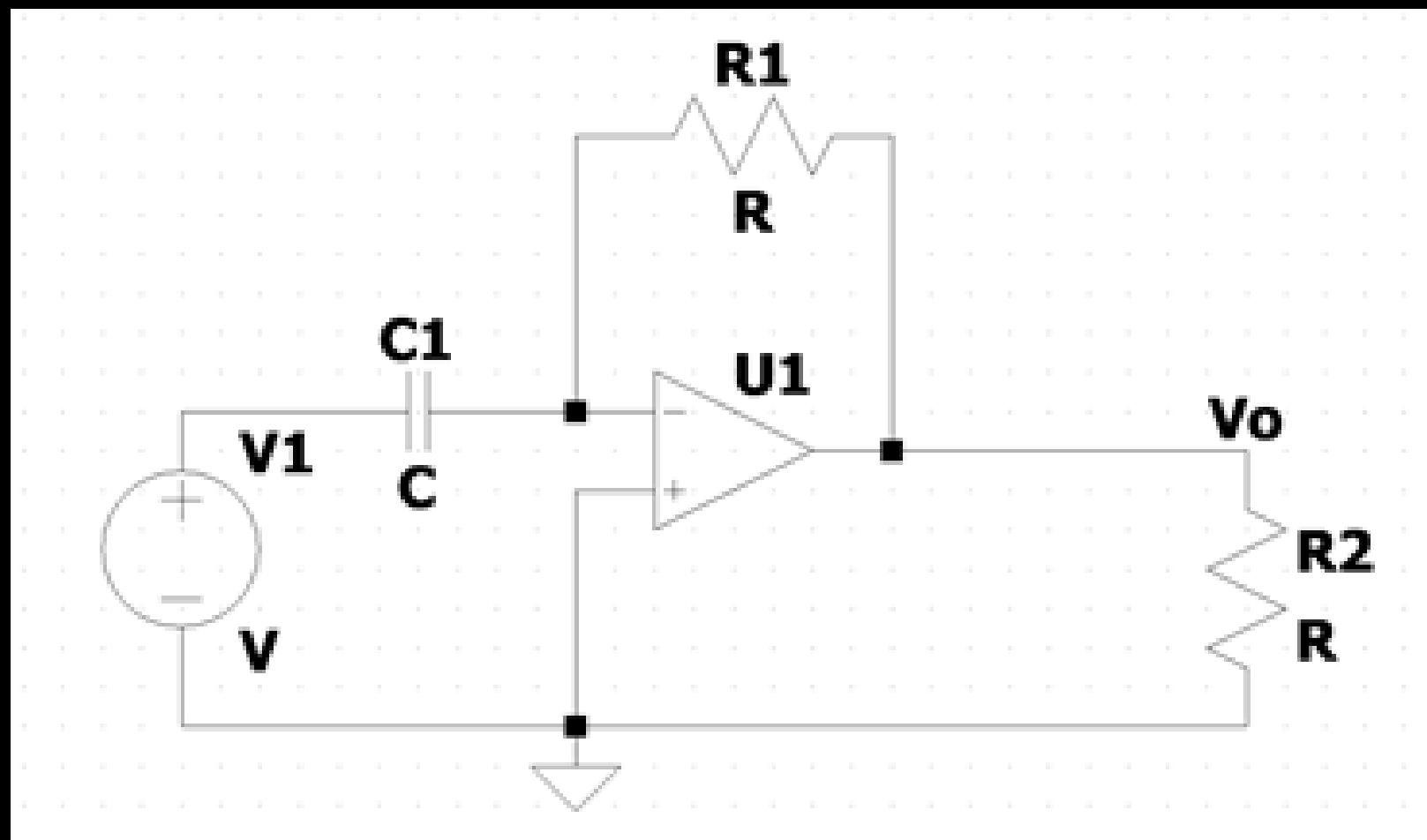
Output Tegangan



Output Arus



ANALISIS PERHITUNGAN RANGKAIAN DIFFERENSIATOR



Berikut ini hubungan antara tegangan input dengan output pada rangkaian tersebut:

$$\begin{aligned} i_r &= i_c \\ \frac{0 - V_o}{R} &= C \frac{d(V_i - 0)}{dt} \\ V_o &= -RC \frac{dV_i}{dt} \end{aligned}$$

Persamaan Tegangan Output pada Rangkaian Differensiator

$$I_o = -C \frac{dV_i}{dt}$$

Persamaan Arus Output pada Rangkaian Differensiator

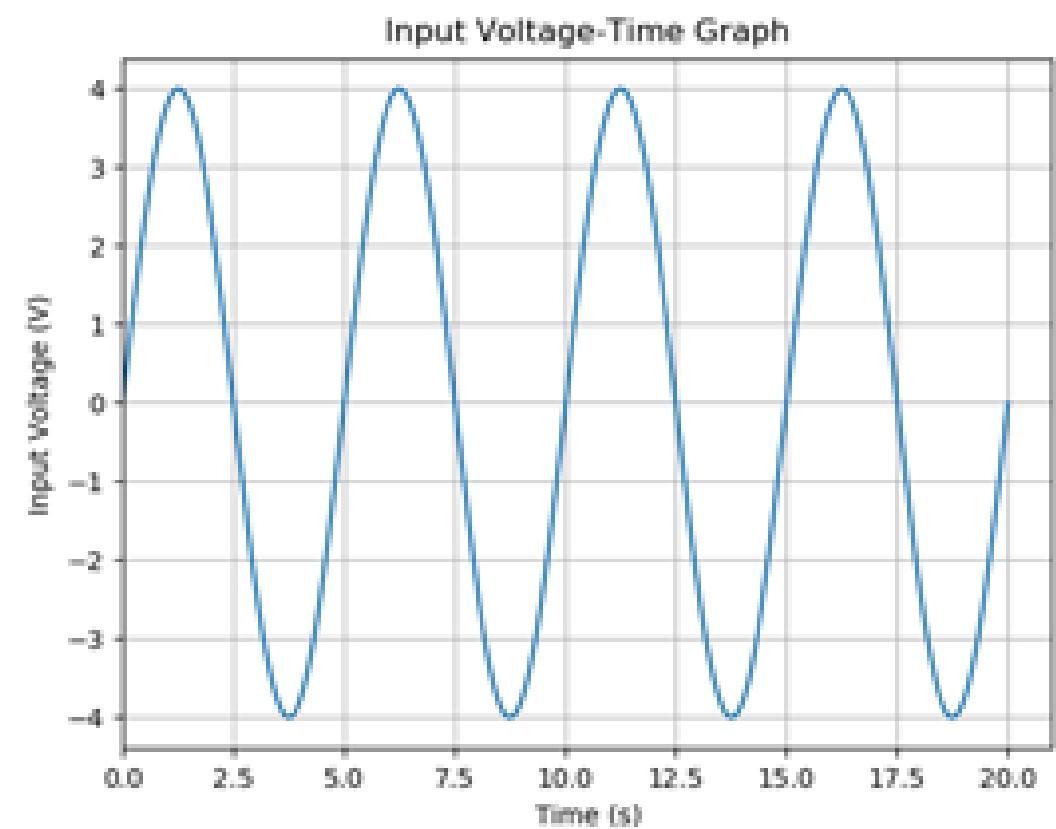
Pada persamaan di atas, terlihat bahwa sinyal tegangan output dari rangkaian tersebut merupakan diferensiasi dari tegangan input dan dikali oleh konstanta $-RC$.

Definition of Derivative (as a function of x)

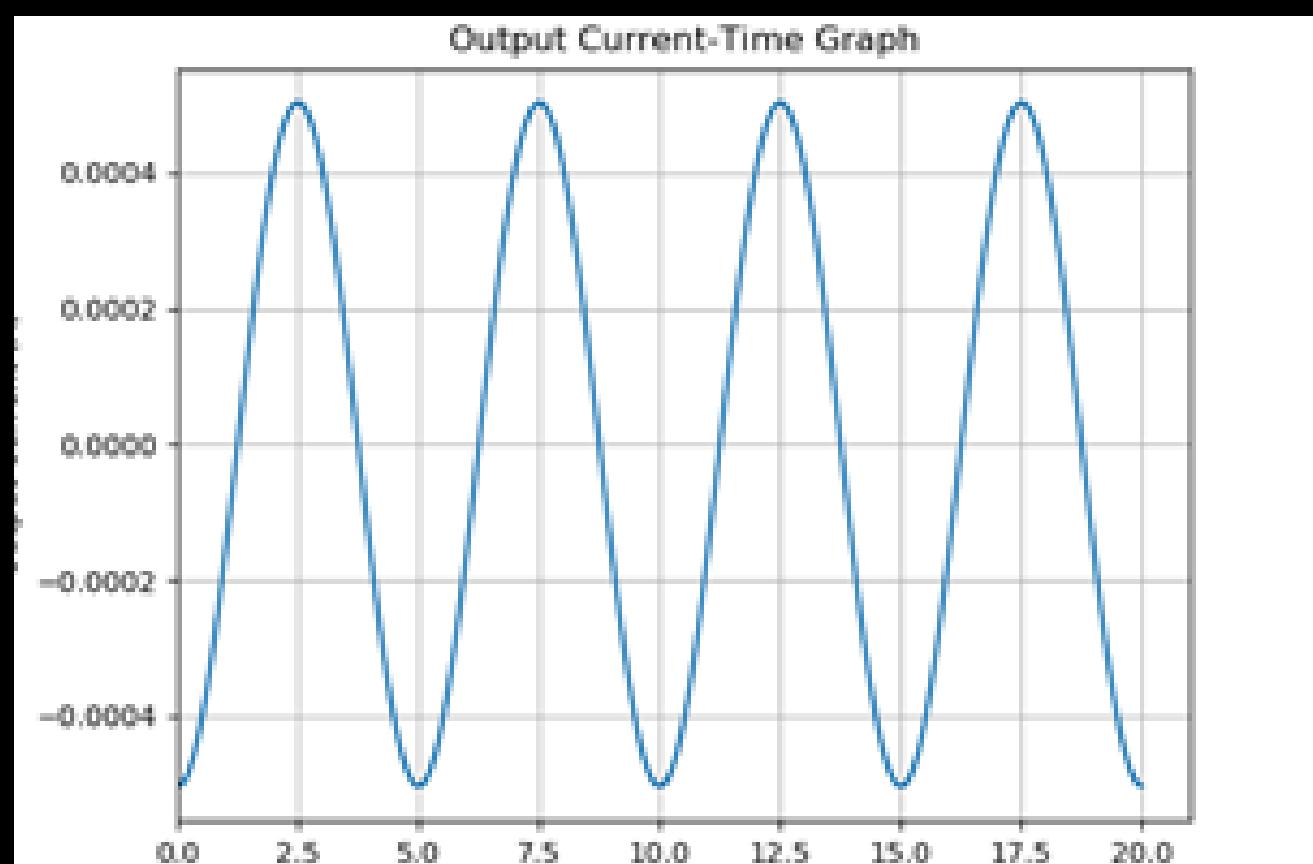
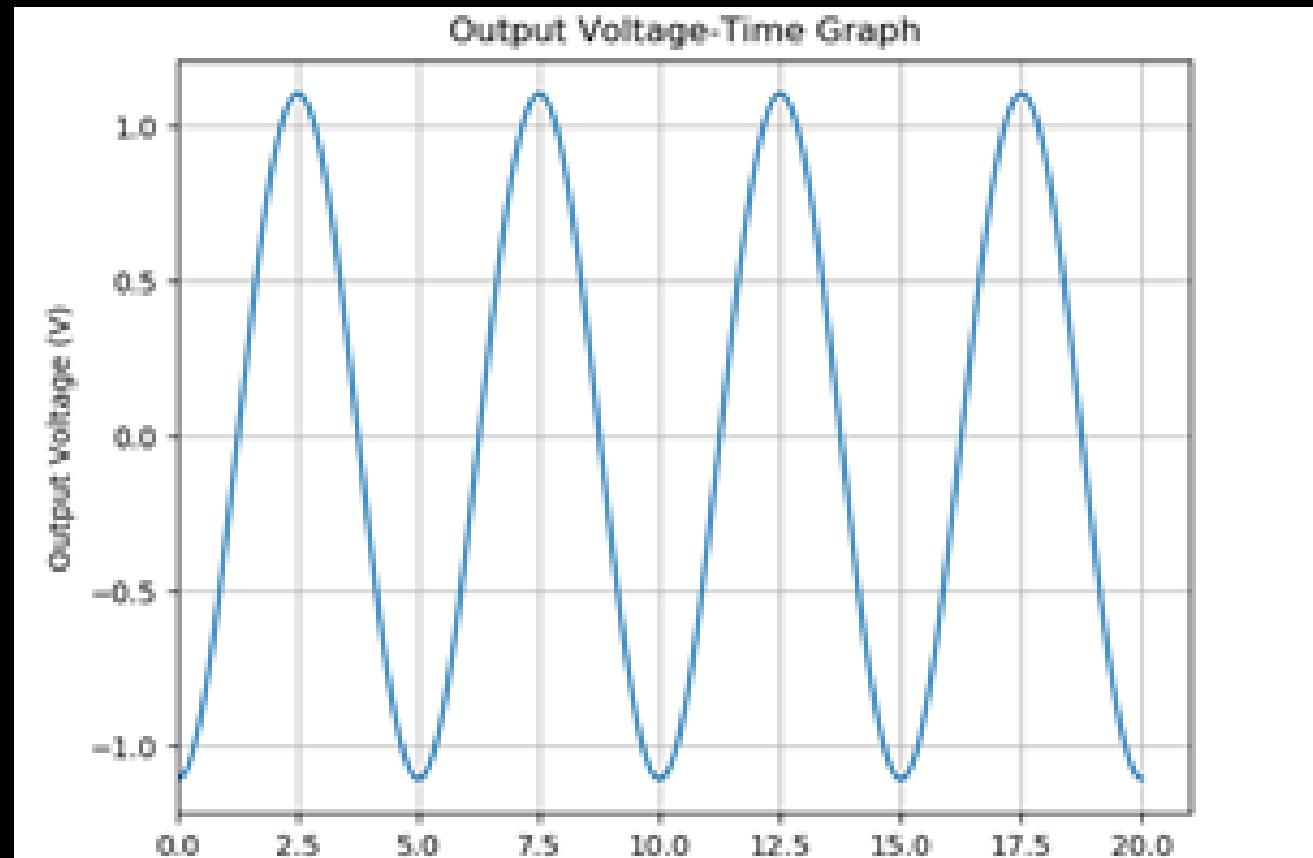
$$f'(x) = \lim_{\Delta x \rightarrow 0} \frac{f(x + \Delta x) - f(x)}{\Delta x}$$

GELOMBANG TEGANGAN DAN ARUS OUTPUT

Berdasarkan jenis gelombang input

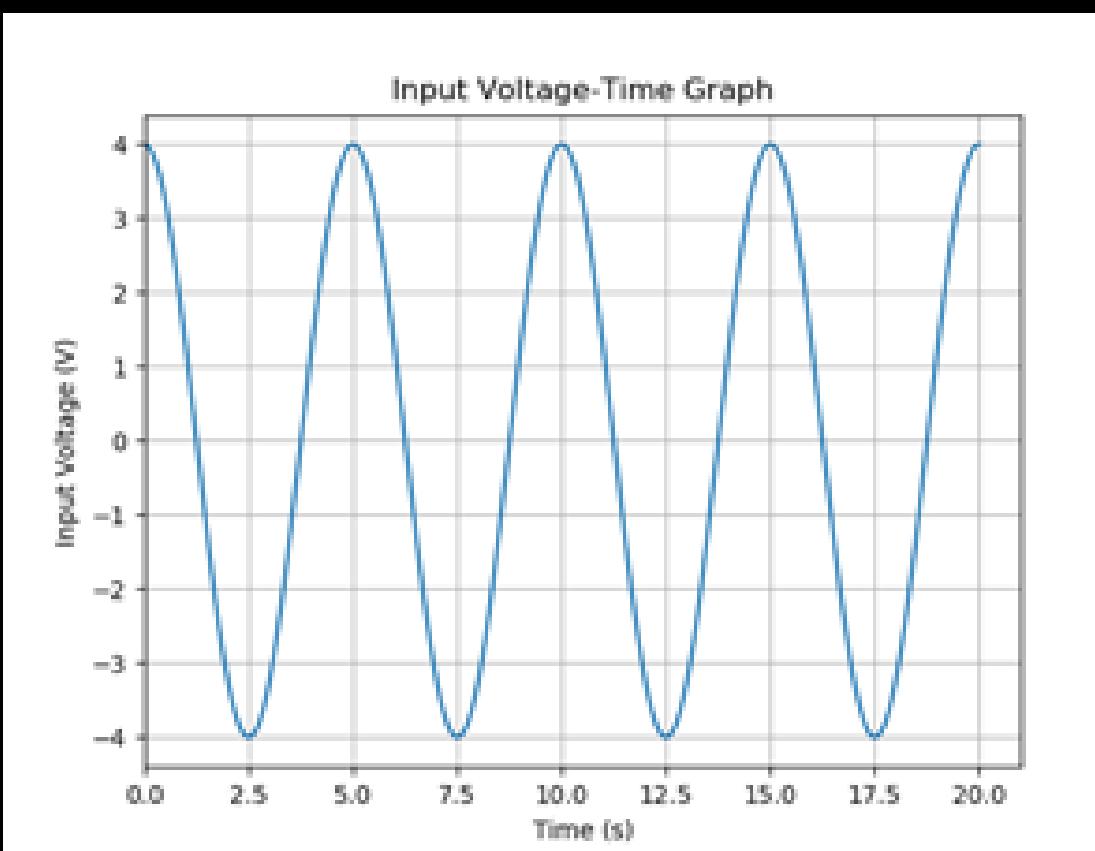


GELOMBANG SINUS

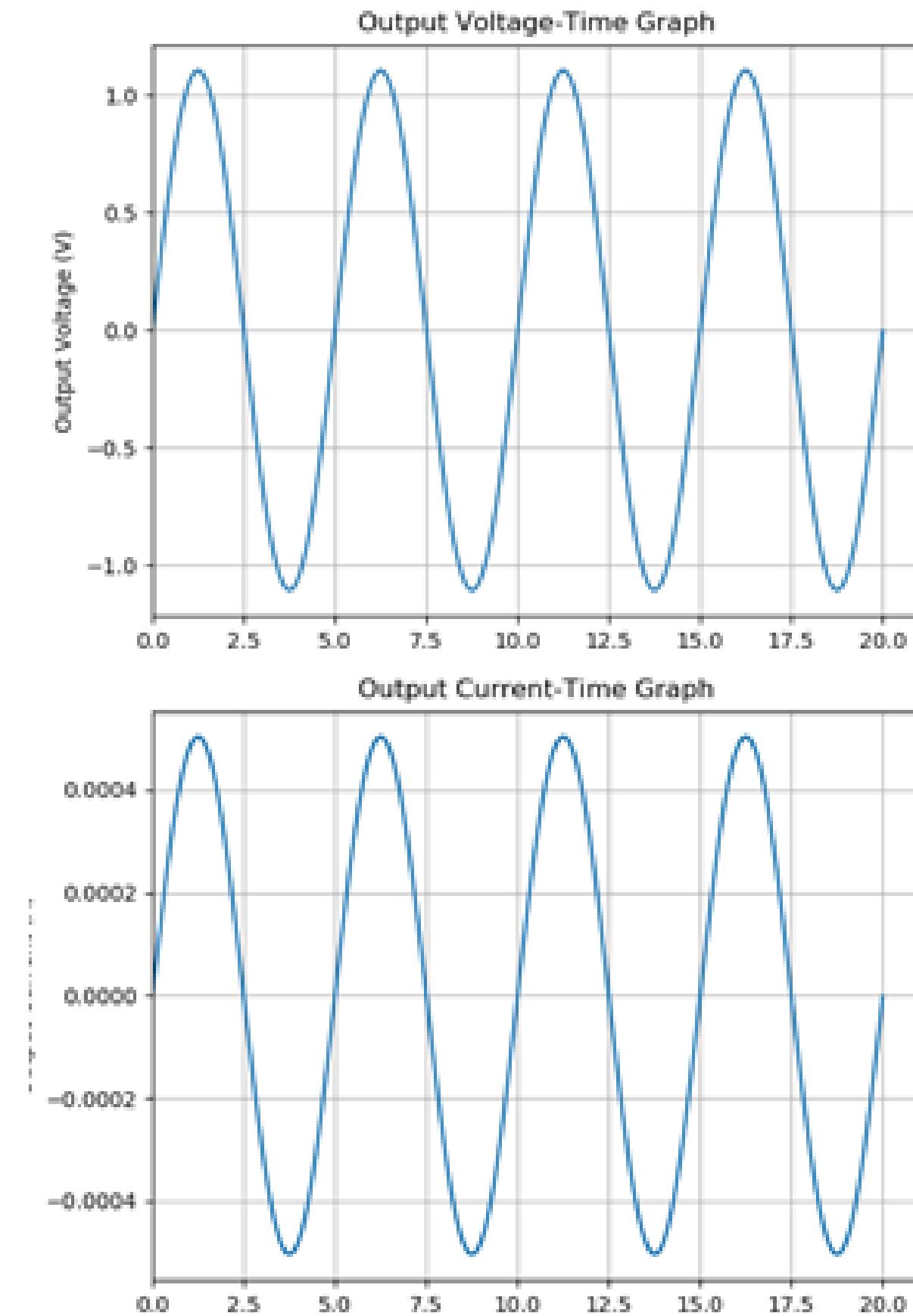


GELOMBANG TEGANGAN DAN ARUS OUTPUT

Berdasarkan jenis gelombang input

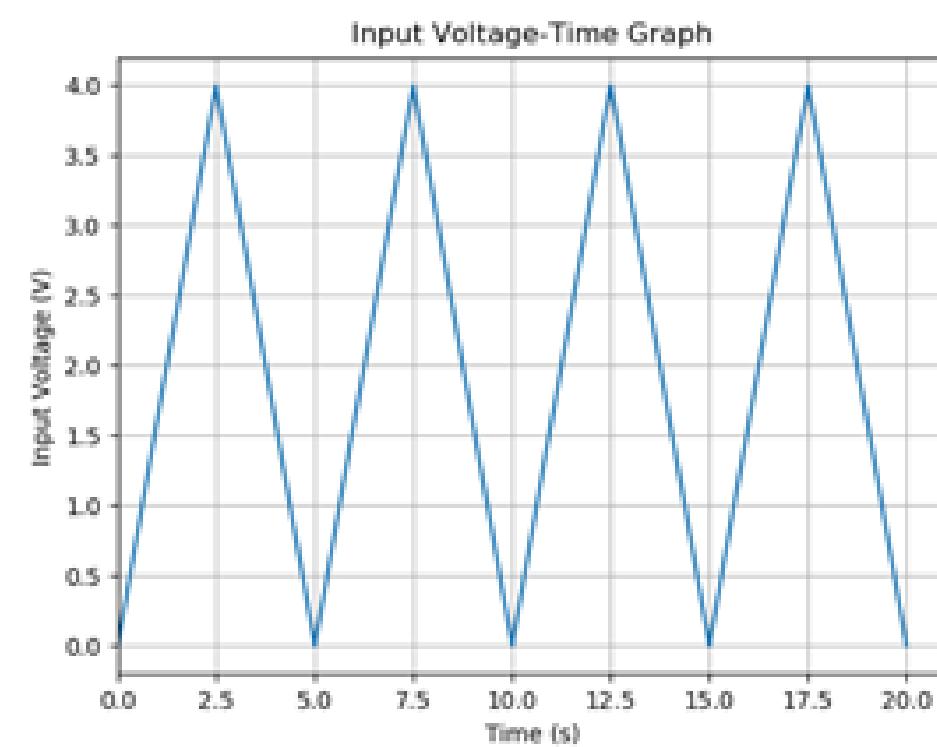


GELOMBANG COSINUS

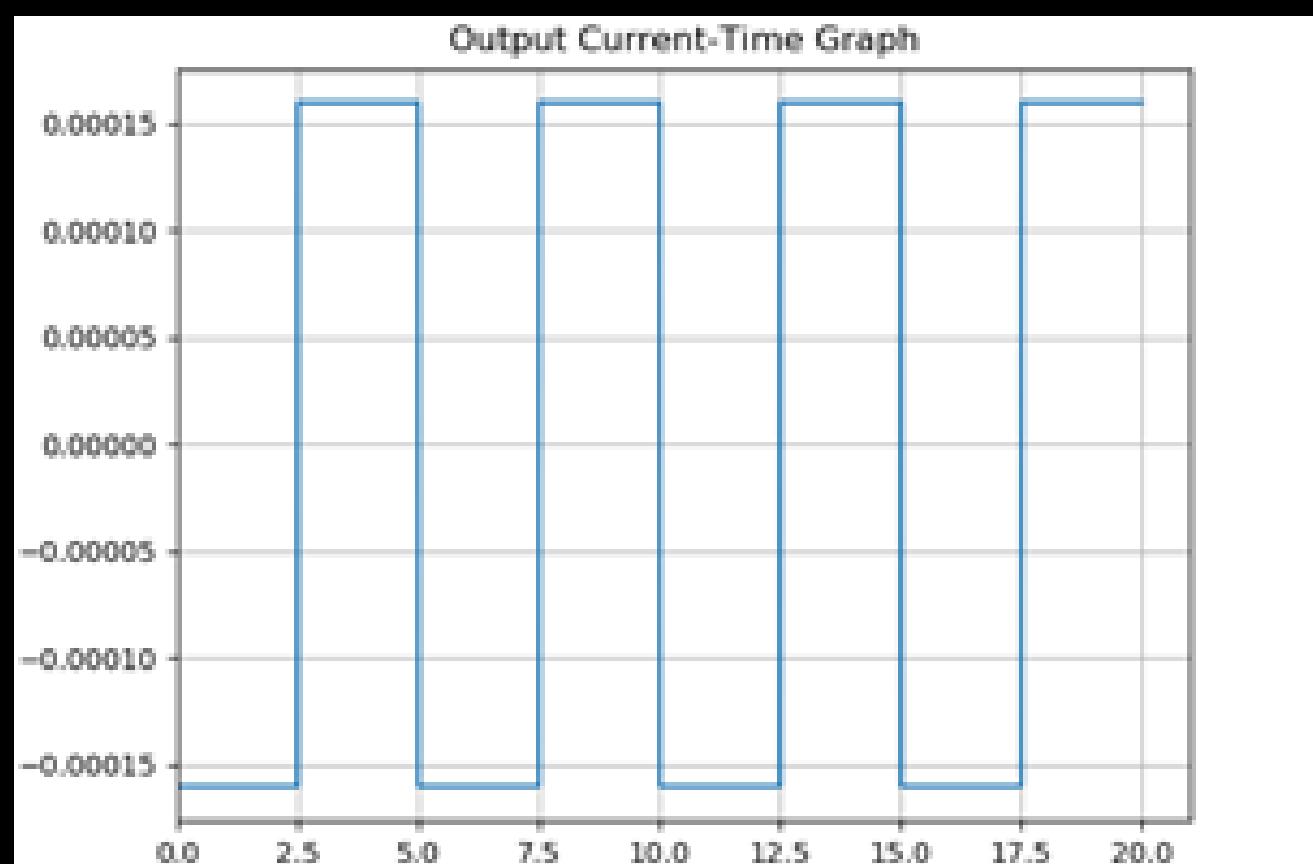
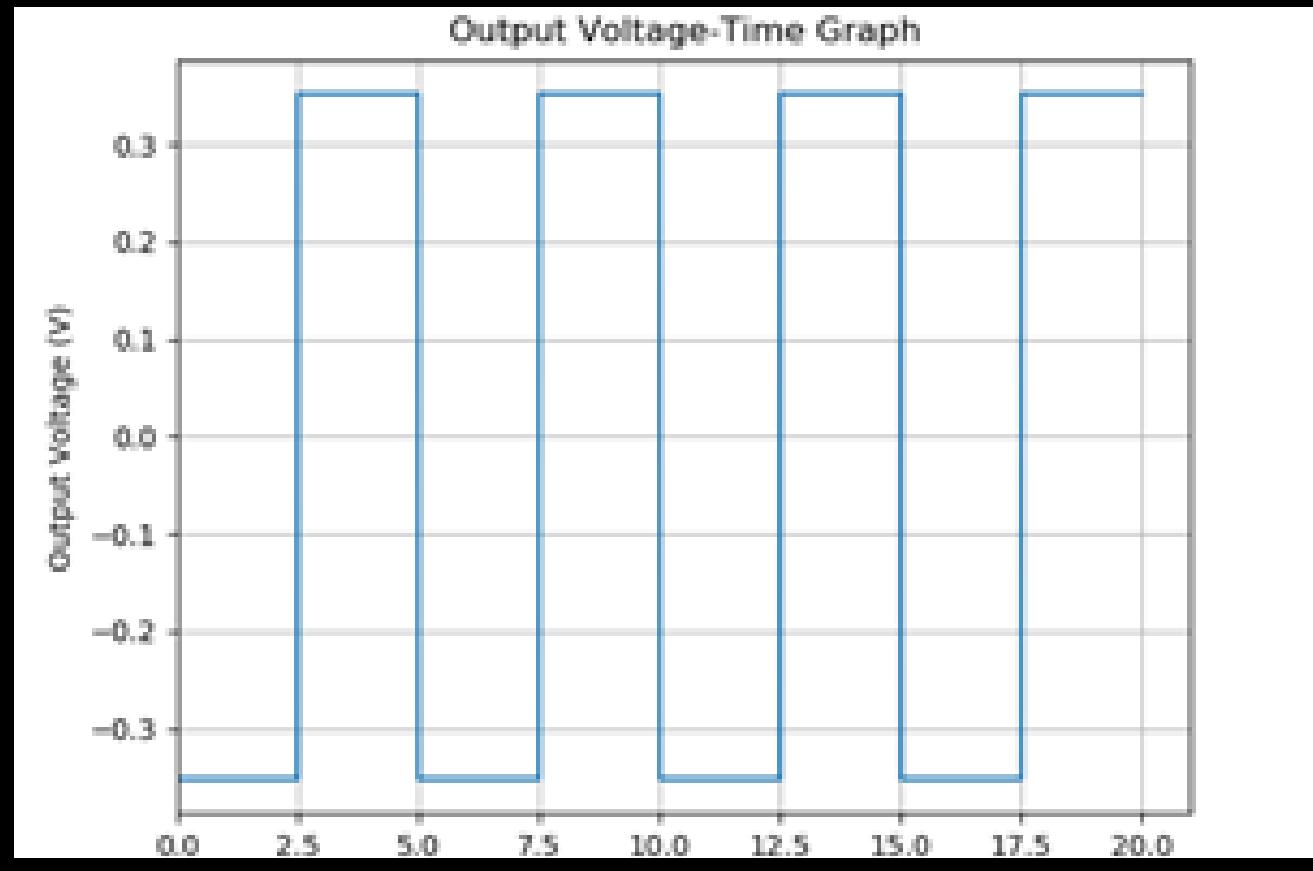


GELOMBANG TEGANGAN DAN ARUS OUTPUT

Berdasarkan jenis gelombang input

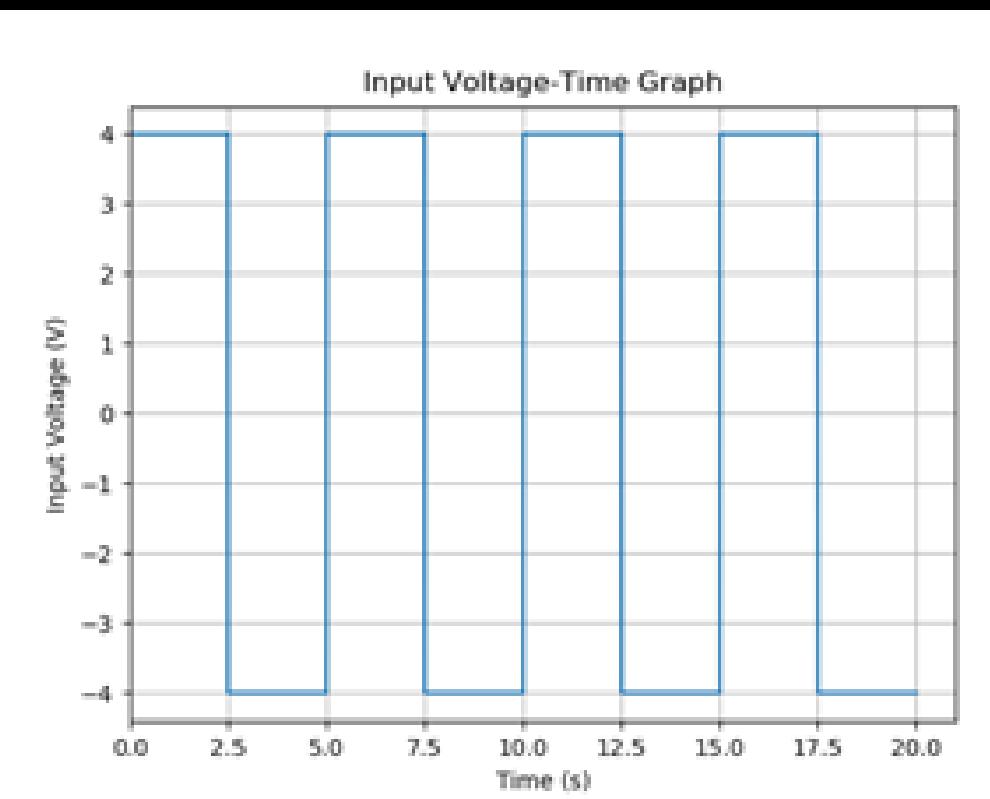


GELOMBANG SEGITIGA

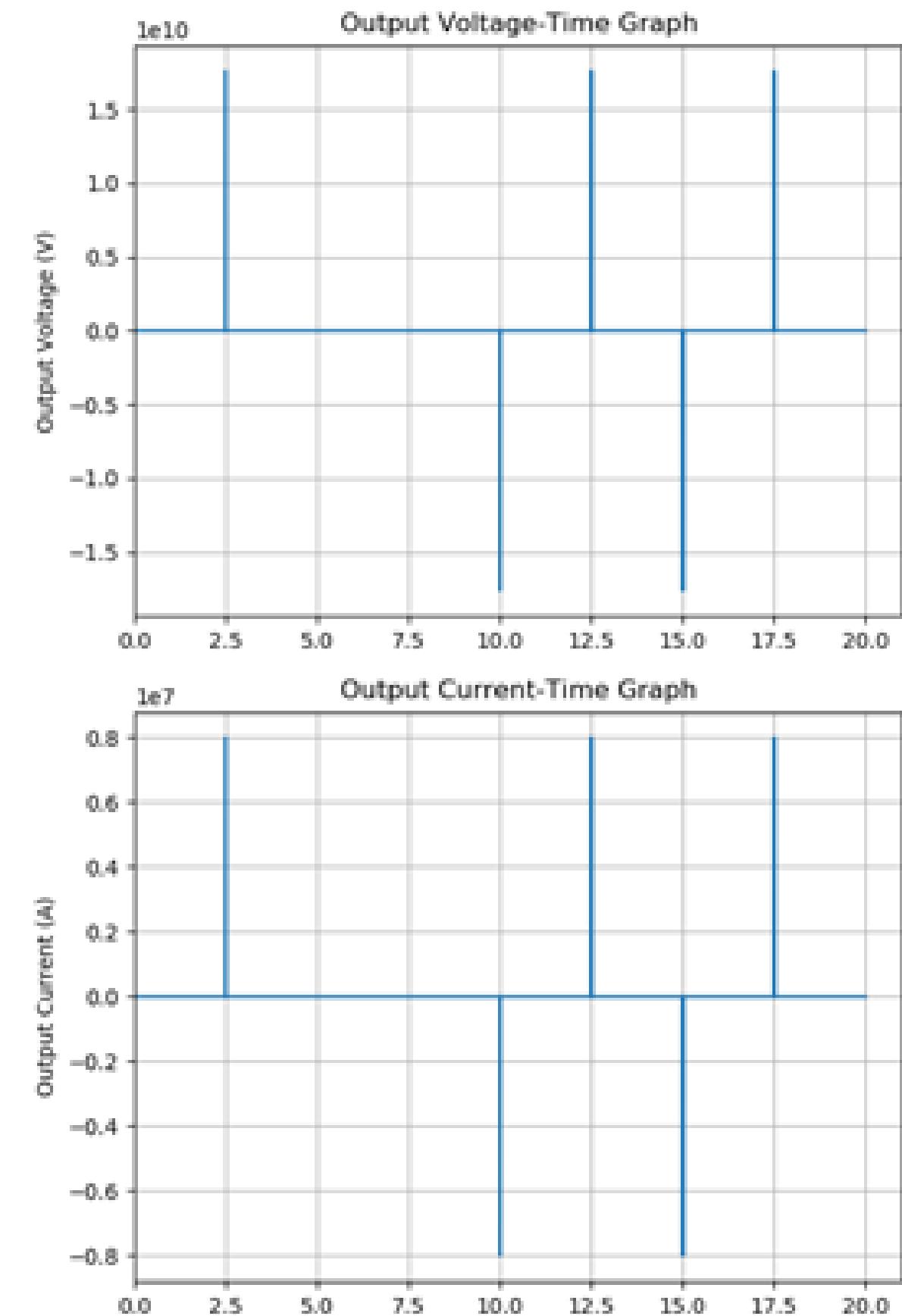


GELOMBANG TEGANGAN DAN ARUS OUTPUT

Berdasarkan jenis gelombang input



GELOMBANG KOTAK



APPENDIX

Penjelasan	Berkas Terkait	Programmer	Tester
Program simulator rangkaian RC Tipe 1	rangkaian1_voltage.c rangkaian1_current.c	Matthew Terence 13218038	
Program simulator rangkaian RC Tipe 2 dan 3	rangkaian2_voltage.c rangkaian2_current.c rangkaian3_voltage.c rangkaian3_current.c	Fazha Ivanda 13218008	
Program simulator rangkaian RC Tipe 4	rangkaian4_voltage.c rangkaian4_current.c	Apria Wati 13218028	
Program simulator rangkaian RC Tipe 5	rangkaian5_voltage.c rangkaian5_current.c		
Program simulator rangkaian <i>differentiator</i> untuk input gelombang sinus	diff_sinus.c		
Program simulator rangkaian <i>differentiator</i> untuk input gelombang cosinus	diff_cosinus.c		Seluruh anggota kelompok
Program simulator rangkaian <i>differentiator</i> untuk input gelombang segitiga	diff_triangular.c	Martinus William Hartono 13218044	
Program simulator rangkaian <i>differentiator</i> untuk input gelombang kotak	diff_square.c		
<i>Graphical User Interface</i> dan integrasi program secara keseluruhan	top_simulator.py		

Thankyou!

STAY SAFE OL