INDRAPRASTHA INSTITUTE *of*
INFORMATION TECHNOLOGY
DELHI

Department
of
Electronics & Communication Engineering

ECE113|Basic Electronics

Lab :3

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Date:4-07-21

Aim: 1) To study response of RC series circuit.

2) To determine time constant of the circuit.

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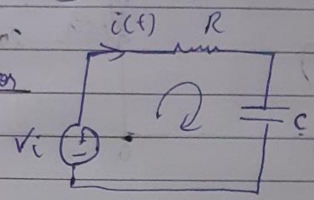
Components: **Resistor, Capacitor, wires, Voltage source, ground.**

Software/Tools Used :

- LT Spice
- Virtual Labs

Theoretical Calculation :

$$\begin{cases} V = 0 & \text{at } t < 0 \\ V = V_0(1 - e^{-t/RC}) \end{cases}$$



For charging the capacitor

Applying KVL

$$V_i - i(t)R - V_i = 0$$

$$V_i - CR\frac{dv_c(t)}{dt} - v_i(t) = 0$$

$$\left[\begin{array}{l} Q = CV \\ \text{diff both side w.r.t } t \\ dQ/dt = C\frac{dv_c}{dt} \\ i(t) = C\frac{d(v_c)}{dt} \end{array}\right]$$

Here it is of the form $\frac{dy}{dx} + Py = 0$

after integration. $v_i(t) = V_i(1 - e^{-t/RC})$ [where $RC = \tau$]

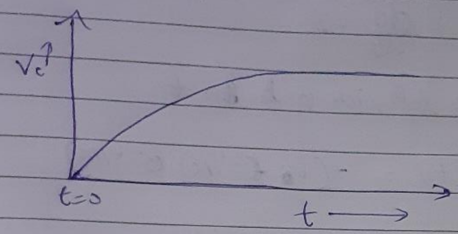
$$v_i(t) = V_i[1 - e^{-t/\tau}]$$

At $t = RC \Rightarrow V = V_0(1 - e^{-1})$

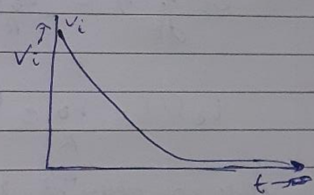
$$V = 0.632V_0$$

Time constant is the time taken by V across capacitor to reach 0.632 time V_0 [when V_0 is voltage at steady state]

At $t = 5RC \Rightarrow V = 0.993V_0$
here capacitor is fully charged



discharging:
$V = 0.368V_i$



Case 1) When $R = 0.5 k\Omega$ $C = 1\mu F$
$\tau = 500 \times 1 \times 10^{-6} = 500\mu s$

$V_C = 5(1 - e^{-5\mu s})$
$V_C = 3.16\ 009010V$

Case 2) $R = 1000\Omega$, $C = 0.1\mu F$
$\tau = 1000 \times 0.1 \times 10^{-6} = 100\mu s$
$V_C = 3.16V$

Case 3) $R = 10k\Omega$, $C = 10\mu F$
$\tau = 10{,}000 \times 10 \times 10^{-6} = 100\mu s$
$V = 3.16V$

Pre test Calculation

1) $\boxed{\tau = RC}$

2) $V = V_0(1 - e^{-t/RC})$

$\cancel{Q = CV \;;\; \frac{dQ}{dt} = I}$

differentiate both side w.r.t to t

$$\frac{dV_c(t)}{dt} = -\left(V_0 \left(-\frac{1}{RC}\right) e^{-t/RC}\right)$$

$$C\frac{dV_c(t)}{dt} = \frac{V_0}{R} e^{-t/RC}$$

$$i_c(t) = \frac{V_0}{R} e^{-t/RC}$$

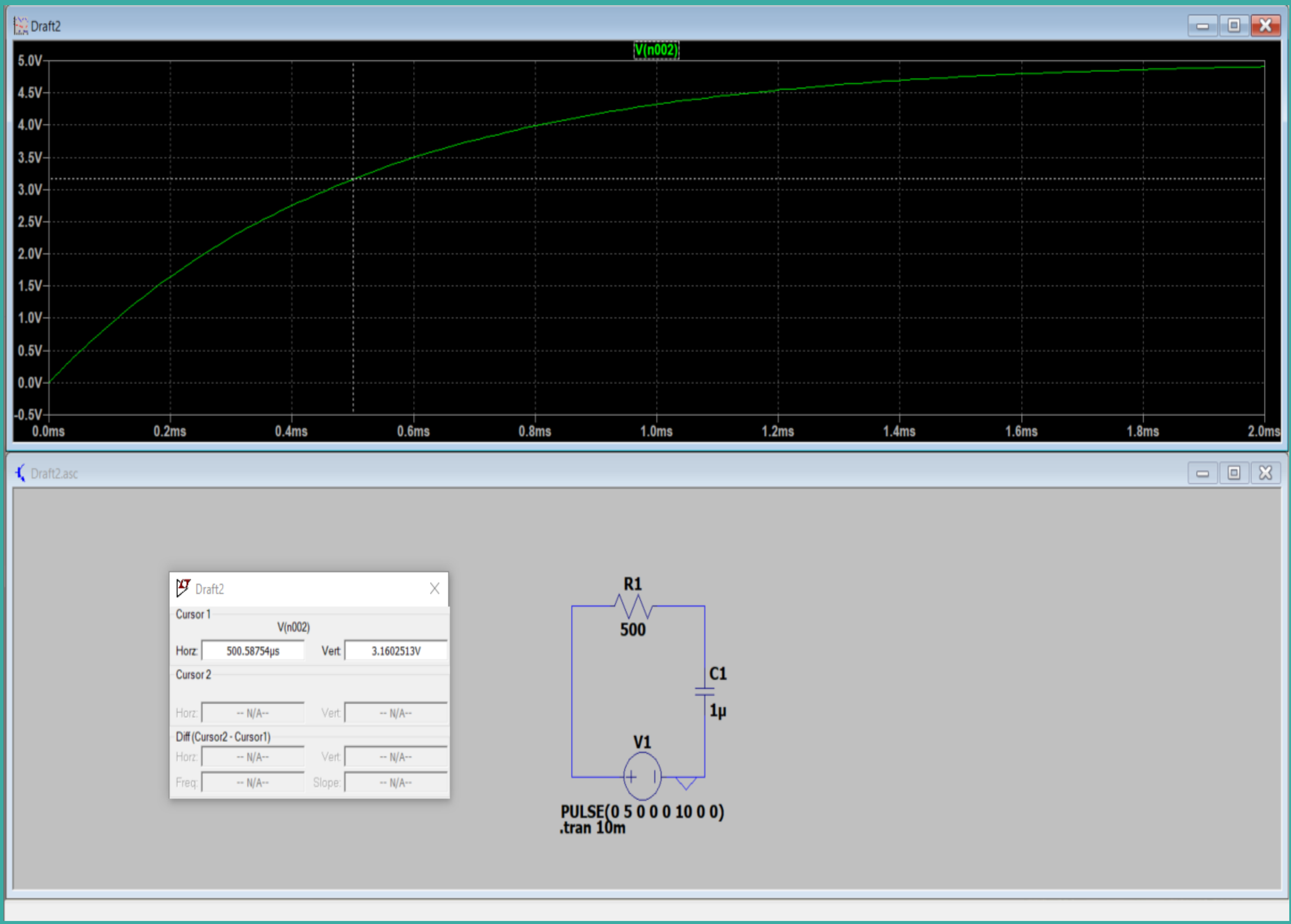
~~Hence~~ so option d is correct

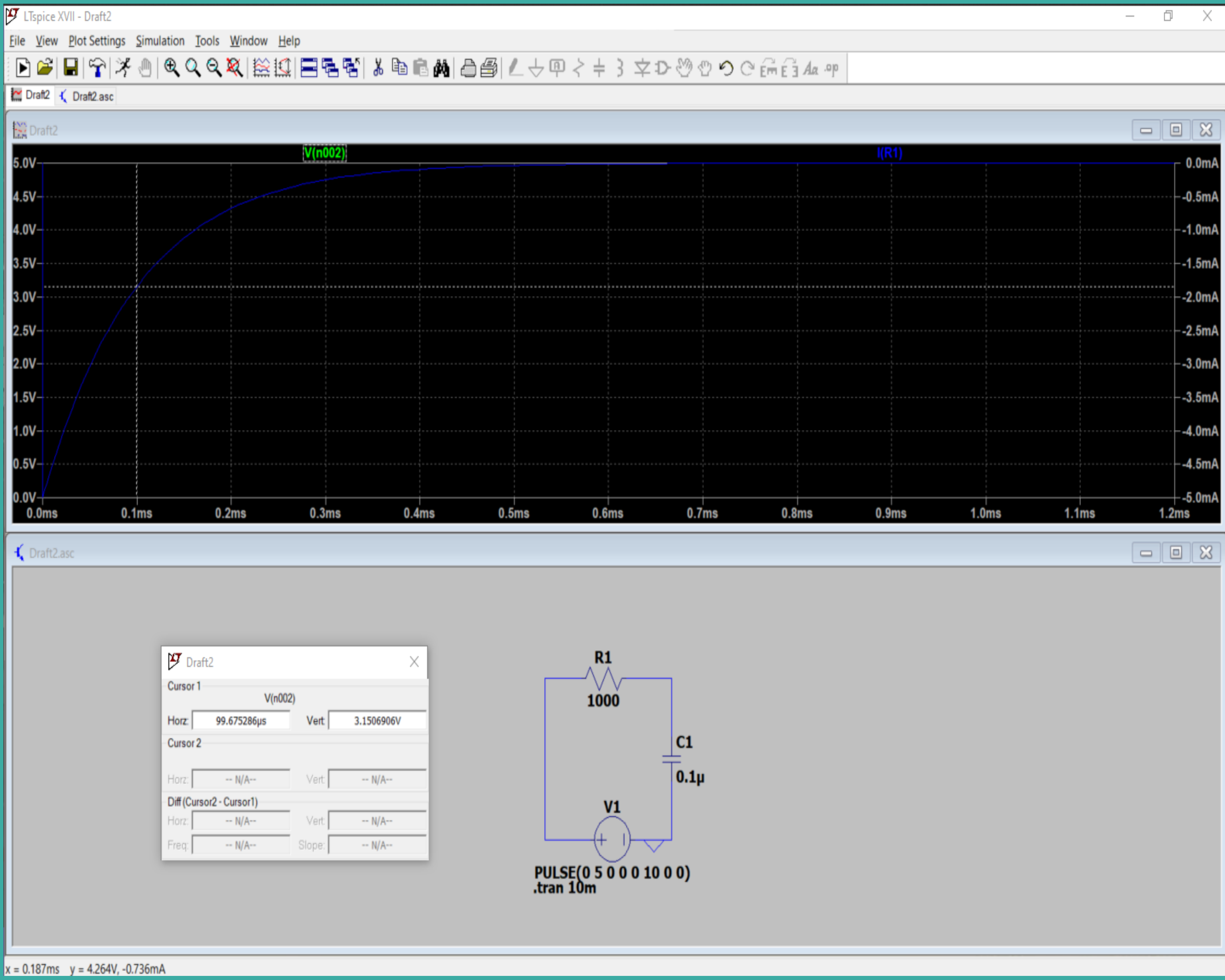
3) At $t = RC \Rightarrow V = V_0(1 - e^{-1})$

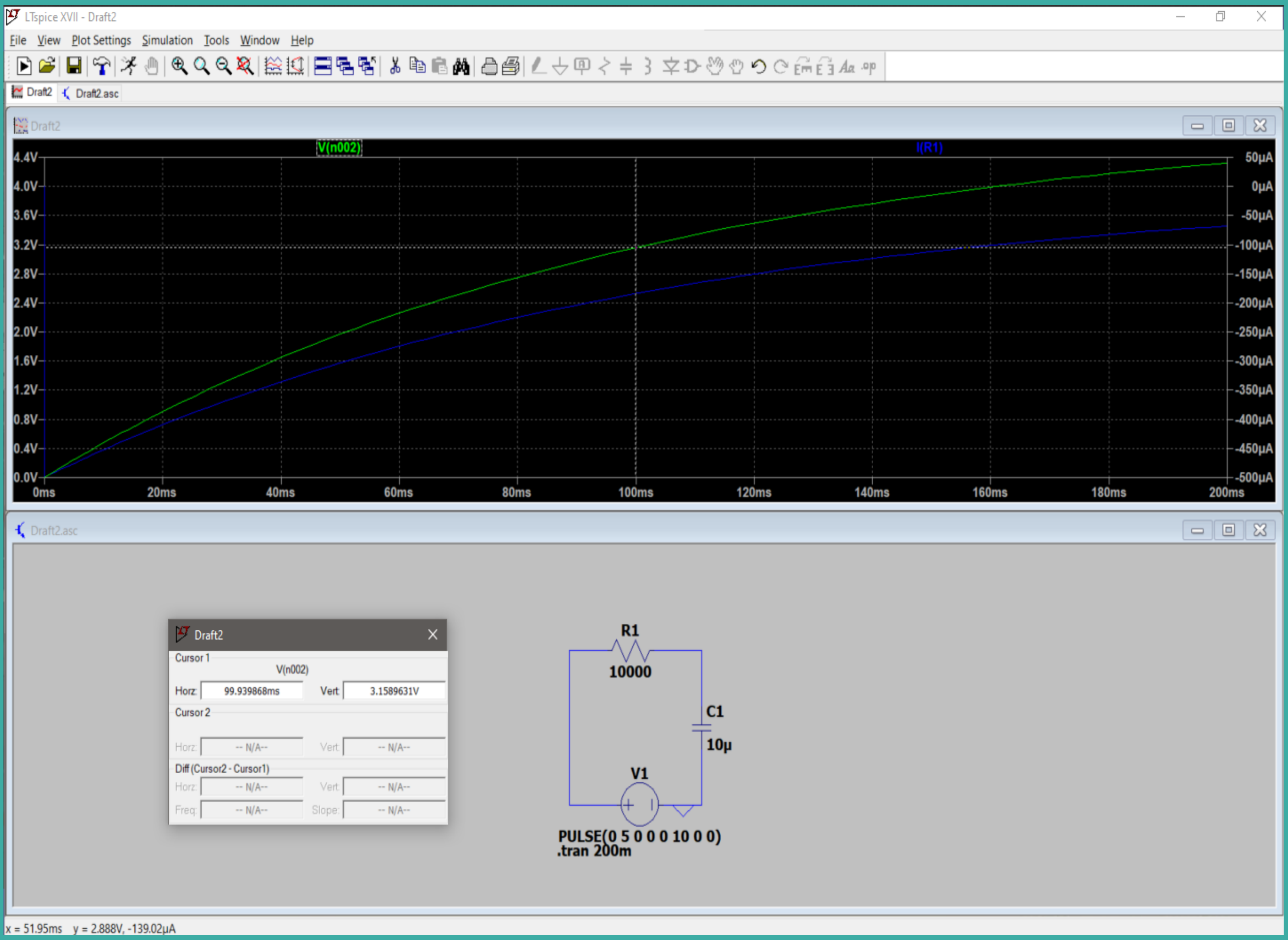
$= 0.632 V_0$

so increase to 0.632 times

Circuit Diagram and Link:



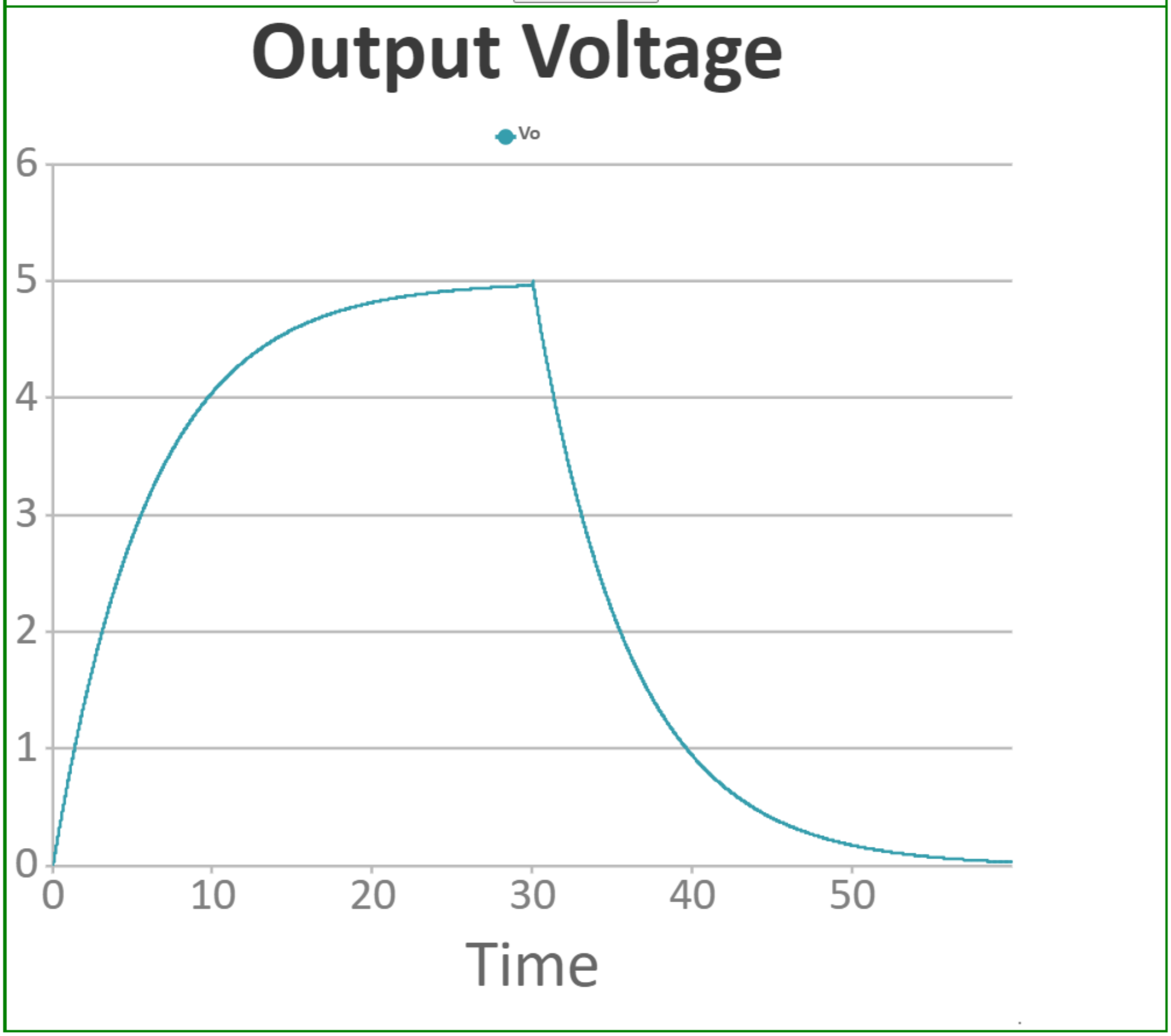

LTspice XVII - Draft2
File View Plot Settings Simulation Tools Window Help
Draft2
Draft2.asc
V(n002)
I(R1)
5.0V
4.5V
4.0V
3.5V
3.0V
2.5V
2.0V
1.5V
1.0V
0.5V
0.0V
0.0mA
-0.5mA
-1.0mA
-1.5mA
-2.0mA
-2.5mA
-3.0mA
-3.5mA
-4.0mA
-4.5mA
-5.0mA
0.0ms 0.1ms 0.2ms 0.3ms 0.4ms 0.5ms 0.6ms 0.7ms 0.8ms 0.9ms 1.0ms 1.1ms 1.2ms
Cursor 1
V(n002)
Horz: 99.675286µs
Vert: 3.1506906V
Cursor 2
Horz: -- N/A--
Vert: -- N/A--
Diff (Cursor2 - Cursor1)
Horz: -- N/A--
Vert: -- N/A--
Freq: -- N/A--
Slope: -- N/A--
R1
1000
C1
0.1µ
V1
PULSE(0 5 0 0 0 10 0 0)
.tran 10m
x = 0.187ms y = 4.264V, -0.736mA

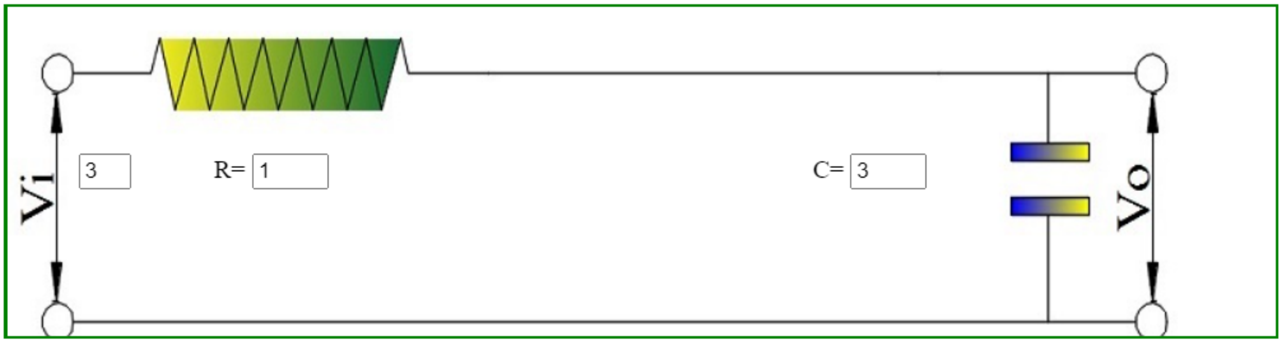

LTspice XVII - Draft2
File View Plot Settings Simulation Tools Window Help
V(n002)
I(R1)
Cursor 1
V(n002)
Horz: 99.939868ms
Vert: 3.1589631V
Cursor 2
Diff (Cursor2 - Cursor1)
R1
10000
C1
10µ
V1
PULSE(0 5 0 0 0 10 0 0)
.tran 200m
x = 51.95ms y = 2.888V, -139.02µA

V_LAB:

Units:=> R in ohms, L in Henry, Vi in Volts, Capacitance in Farad and Time in Seconds

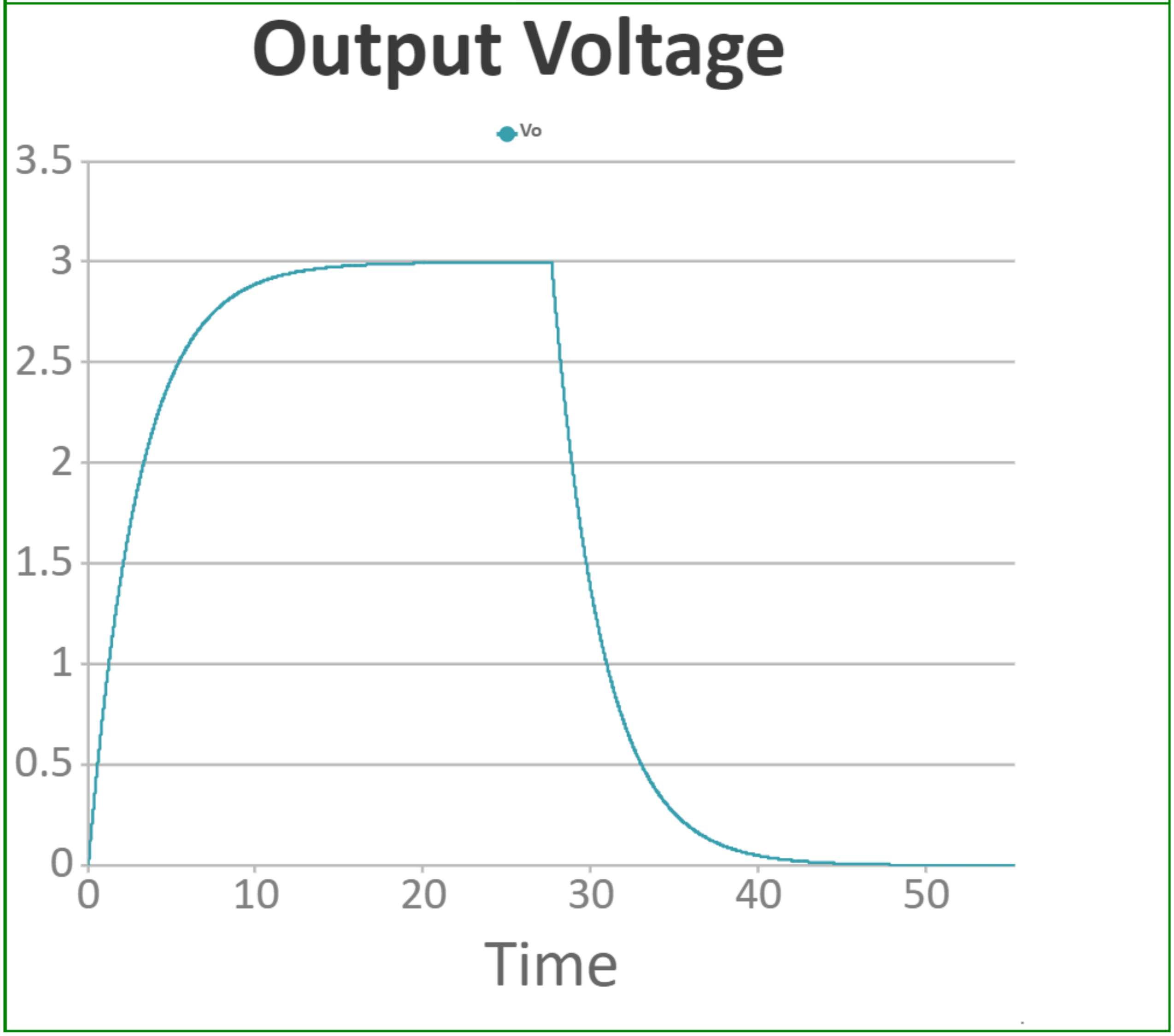
solve

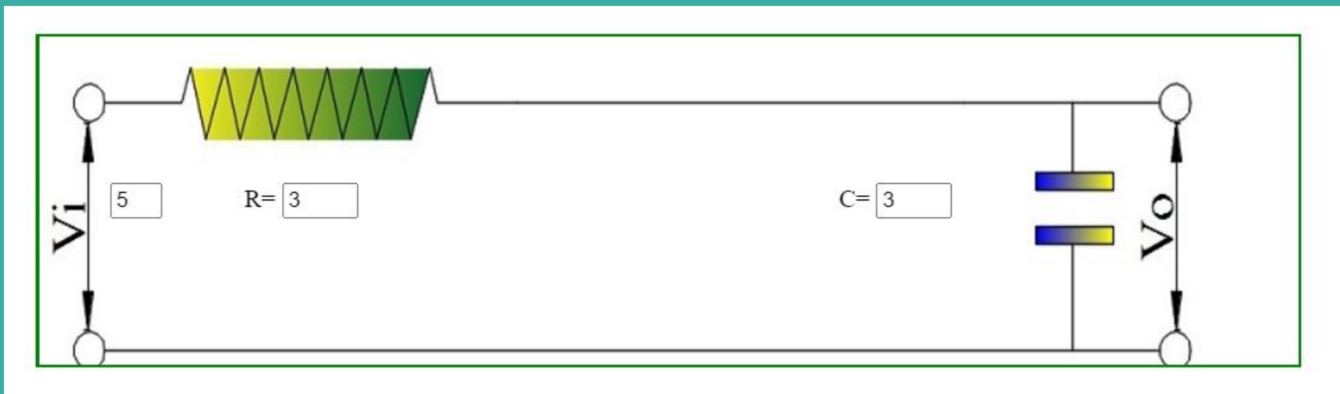


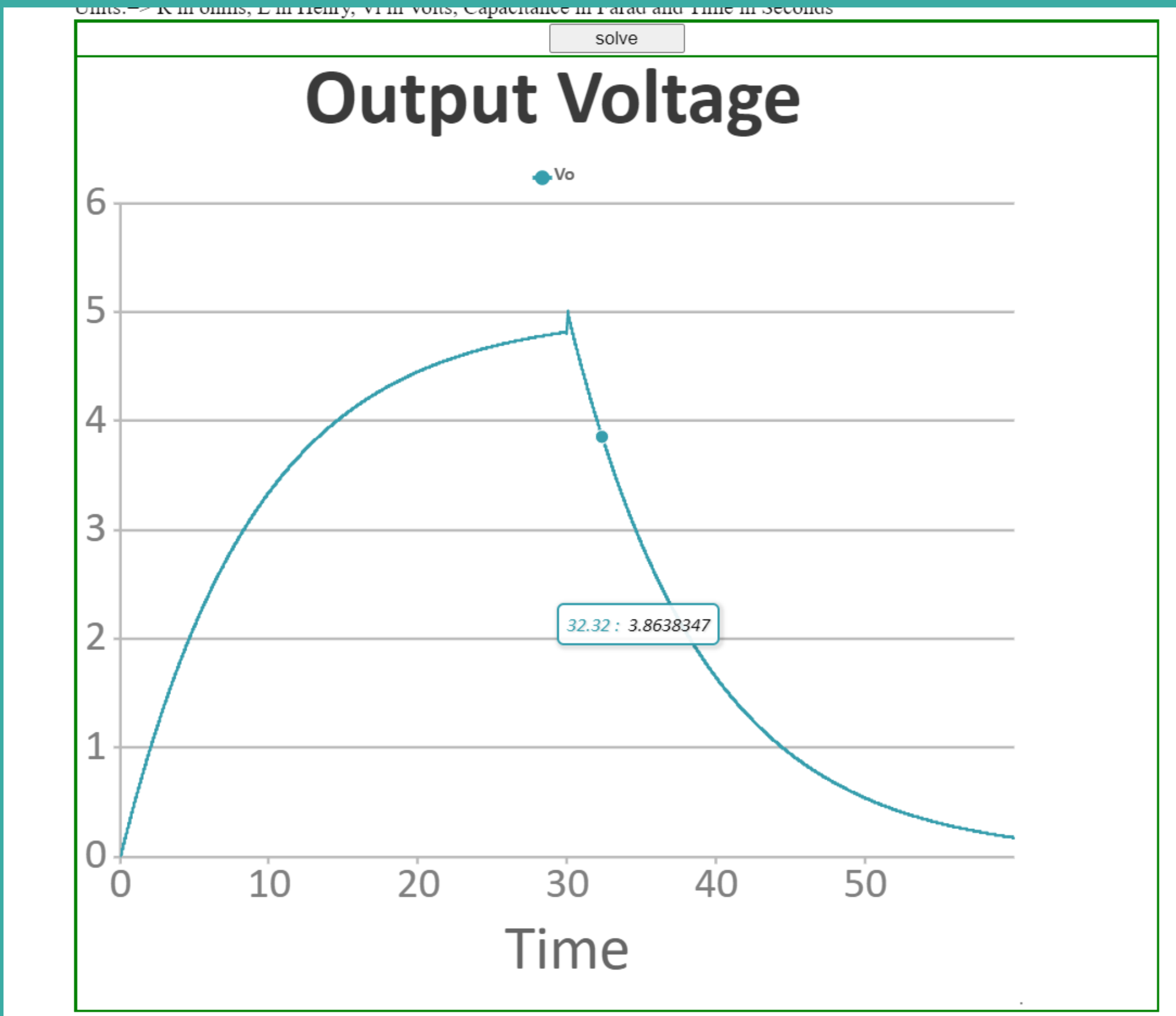


Units:=> R in ohms, L in Henry, Vi in Volts, Capacitance in Farad and Time in Seconds

solve




5
R= 3
C= 3
Vi
Vo


solve
Output Voltage
Vo
32.32 : 3.8638347
Time

V_LAB OBSERVATION TABLE:

			Charging-	------------	Discharging	------------
V(v)	R(ohm)	C(F)	Voltage(V)	Time(s)	Time(s)	Voltage(v)
5	2	3	4.99	29.72	59.86	0.02
3	1	3	3	27.64	49.71	0.01
5	3	3	5	30	59.99	0.01

Observations/Results:

When circuit is charging then voltage vs time graph first increase then finally reach to saturation. The current flowing through the capacitor shows exponential decay as it suddenly reaches to max value.

We observed the response of RC series circuit and determine time constant of the circuit.

Applications:

- Used in camera flash
- Rc circuit is used to filter signals.