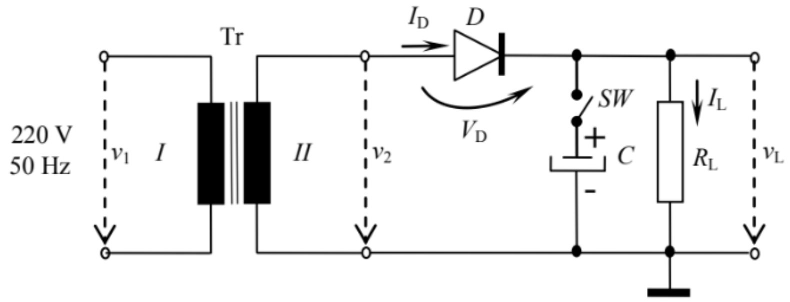
THE HALF WAVE RECTIFIER

❖ ***Theoretical Summary***

A rectifier is a device that converts the sinusoidal alternating current (AC) into somewhat constant direct current (DC). Half wave rectifiers converts only one half-cycle of the AC voltage (positive in our case) and will block the other half.

The half wave rectifier is connected to a sinusoidal AC voltage source of 220V RMS and 50Hz through a step-down transformer, that steps the voltage down to ≈ 13.3V RMS (≈ 37.8V peak to peak).



- ***Components***
  a. Tr – Step-Down Transformer
  - used to lower the voltage between the 2 circuits, while also increasing the current by the same factor
  - N_1 – nr. of coil turns from I
  - N_2 – nr. of coil turns from II (< N_1)
  - V_{1m} – voltage amplitude of I
  - V_{2m} – voltage amplitude of II
  - $n = \frac{\mathrm{N1}}{\mathrm{N2}} = \frac{\mathrm{V1m}}{\mathrm{V2m}}$ – transformation ratio

  b. D – Diode
  - constitutes the rectifier of the circuit
  - allows current to pass only in one direction, the positive half of the input sinusoidal wave

  c. C – Capacitor
  - makes up the low-pass filter
  - used to smoothen the pulsating DC waveform

  d. R_L – Load Resistor

- ***Values***
  - R_L = 5kΩ
  - C – cases:
    i. No capacitor
    ii. 1 capacitor – C = 22µF
    iii. 2 capacitors in parallel – C = 44µF
    iv. 3 capacitors in parallel – C = 66µF
    v.
- ***Formulas***
  - $Vm = \frac{Vpp}{2}$

- $T = \frac{1}{f}$
- $V_{LDC} = \frac{V_{2m}}{\pi}$ (no capacitor)
- $\Delta v_L = \frac{V_{2m}}{C \cdot R \cdot f}$, $V_{LDC} = V_{2m} - \frac{\Delta v_L}{2}$ (with capacitor)

❖ ***Experimental Procedure***
- make the circuit above
- using a multimeter (VAC domain), it is measured the voltage given by the transformer secondary -> amplitude (A = V_{2m}) & time period (T)
- For the 4 cases: SW open, SW closed(1C, 2C & 3C):
    - output waveform $v_L(t)$ is observed
    - measurements are took for the DC component of the output voltage V_{LDC} and the ripple Δv_L

❖ ***Measurements – taken from screenshots of oscilloscope(lab 3)***
- $f = 50Hz => T = 20\,ms = 0.02s$

- **Case I – No C**

$$V_{2pp} = 37.8V => V_{2m} = \frac{37.8}{2} = 18.9V$$

$$V_{LDC} = 5.80V$$

- **Case II – 1 C**

$$V_{2pp} = 37.4V => V_{2m} = \frac{37.4}{2} = 18.7V$$

$$\Delta v_L = 1.88V$$
$$V_{LDC} = 17.76V$$

- **Case III – 2 C**

$$V_{2pp} = 37.4V => V_{2m} = \frac{37.4}{2} = 18.7V$$

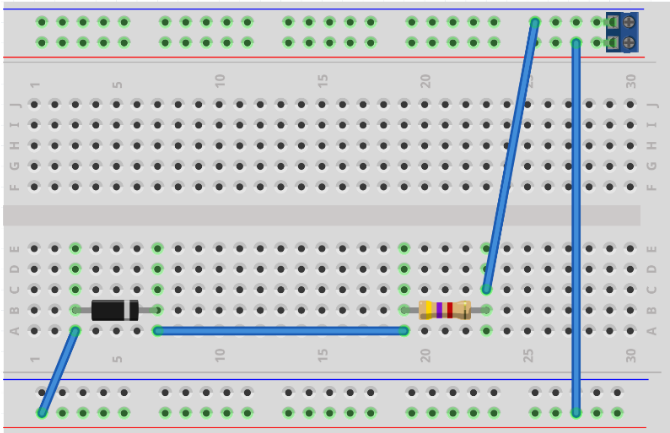
$$\Delta v_L = 1.1V$$
$$V_{LDC} = 18.15V$$

- **Case IV – 3 C**

$$V_{2pp} = 37.4V => V_{2m} = \frac{37.4}{2} = 18.7V$$

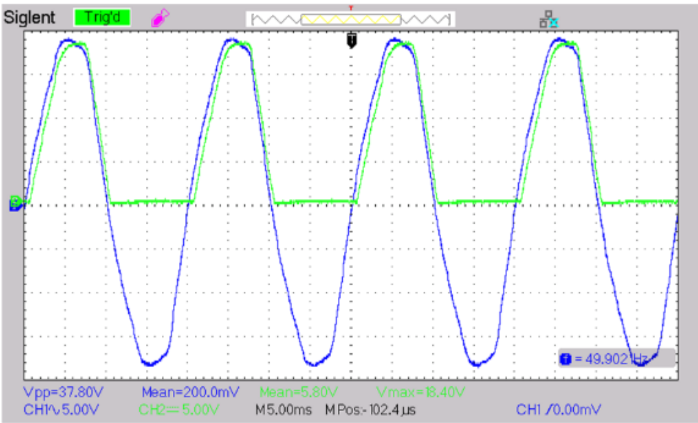
$$\Delta v_L = 0.74V$$
$$V_{LDC} = 18.33V$$

CASE I

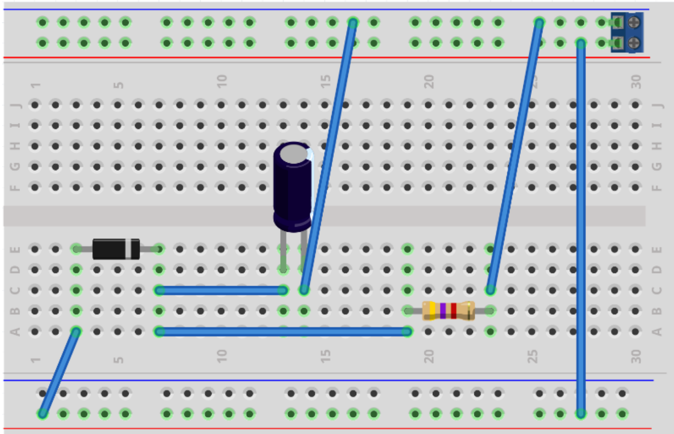


Redresor monoalternanță

Fără filtru capacitiv

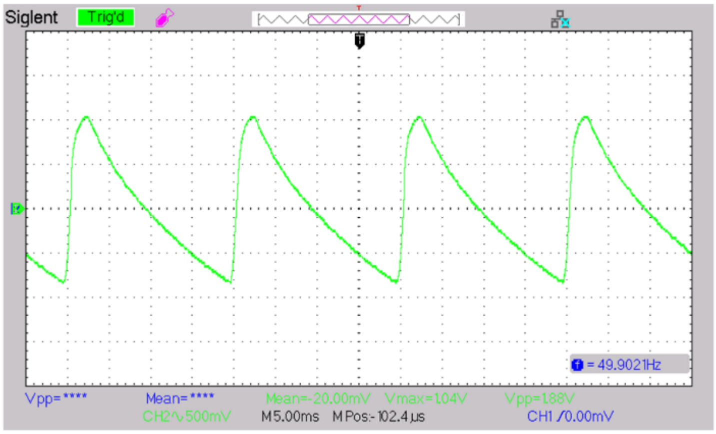


CASE II

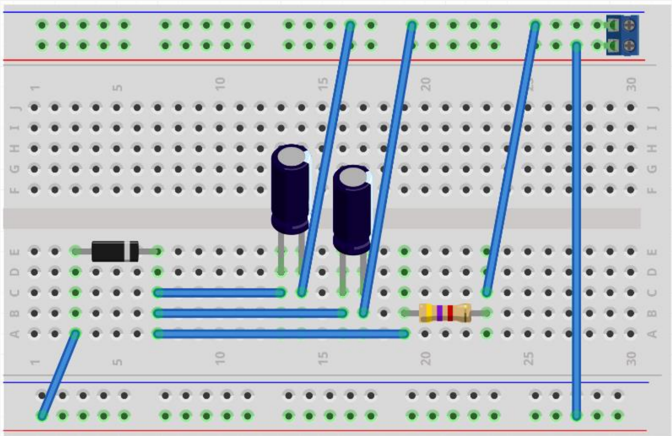


Redresor monoalternanță

Cu filtru capacitiv – doar ondulația $C=22\ \mu F$

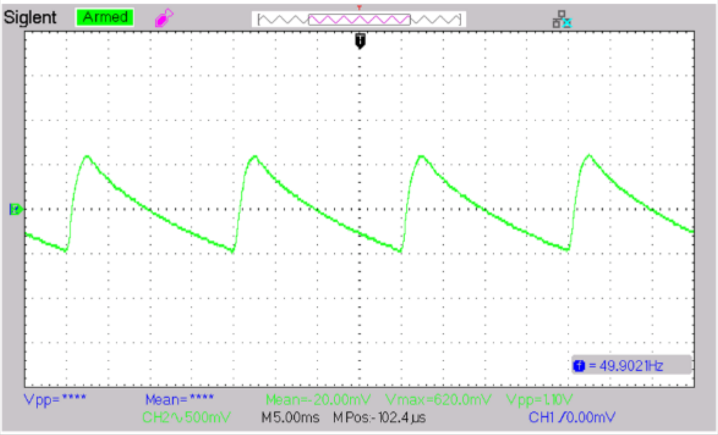


CASE III

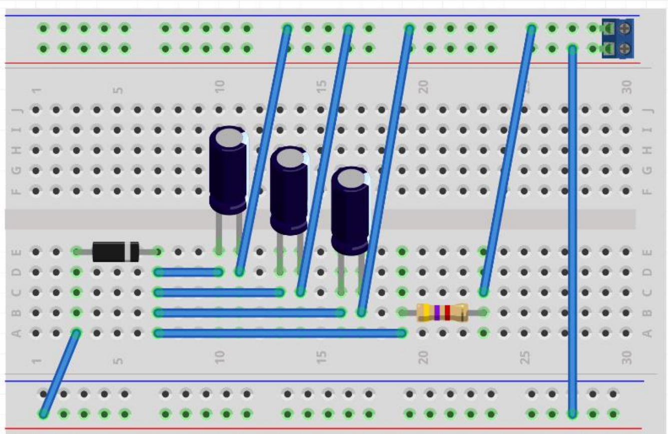


Redresor monoalternanță

Cu filtru capacitiv – doar ondulația $C=44\ \mu F$

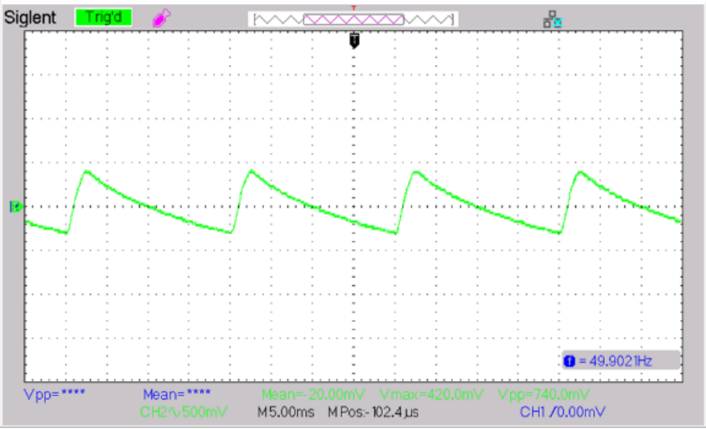


CASE IV



Redresor monoalternanță

Cu filtru capacitiv – doar ondulația $C= 66\ \mu F$



❖ *Calculations*

- $V_{2pp} = 37.8V => V_{2m} = \frac{37.8}{2} = 18.9V$
- $f = 50Hz => T = 20\ ms = 0.02s$

▪ Case I – No C

$$V_{LDC} = \frac{18.9}{\pi} = 6.02V$$

▪ Case II – 1 C

$$\Delta v_L = \frac{18.9}{22 \cdot 5 \cdot 50 \cdot 10^{-3}} = 3.44V$$

$$V_{LDC} = 18.9 - \frac{3.44}{2} = 17.18V$$

▪ Case III – 2 C

$$\Delta v_L = \frac{18.9}{44 \cdot 5 \cdot 50 \cdot 10^{-3}} = 1.72V$$

$$V_{LDC} = 18.9 - \frac{1.72}{2} = 18.04V$$

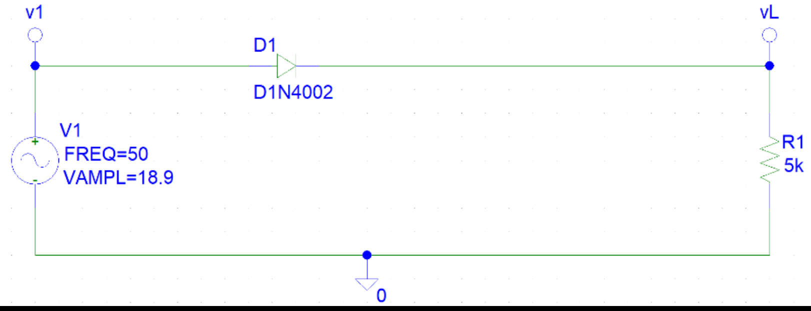
▪ Case IV – 3 C

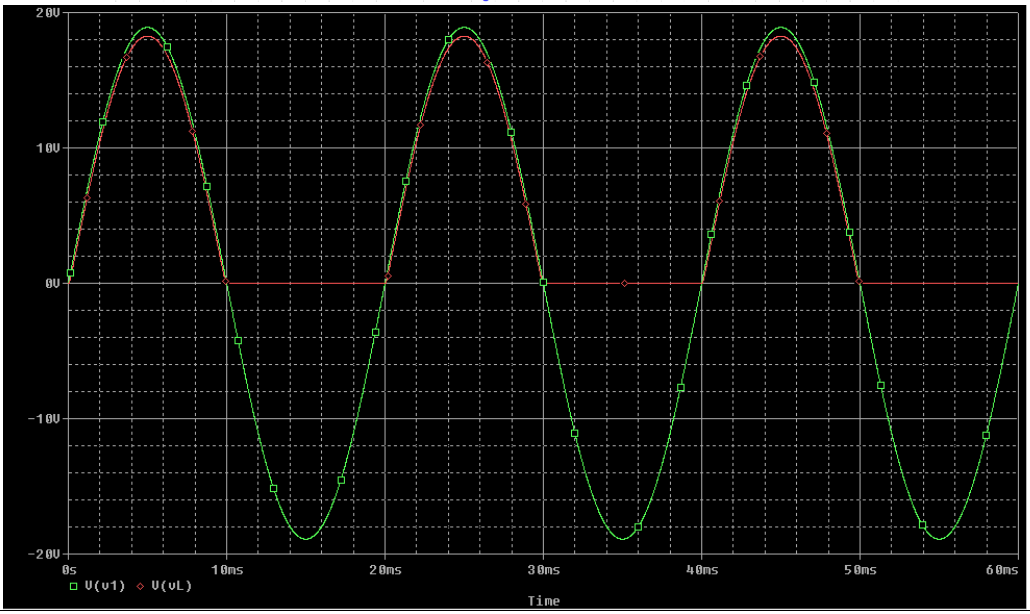
$$\Delta v_L = \frac{18.9}{66 \cdot 5 \cdot 50 \cdot 10^{-3}} = 1.15V$$

$$V_{LDC} = 18.9 - \frac{1.15}{2} = 18.33V$$

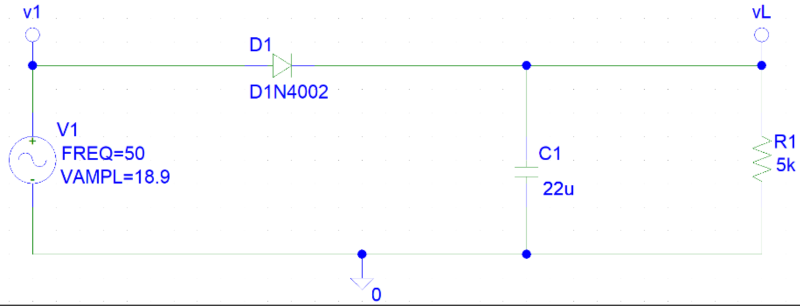
❖ *Simulations*

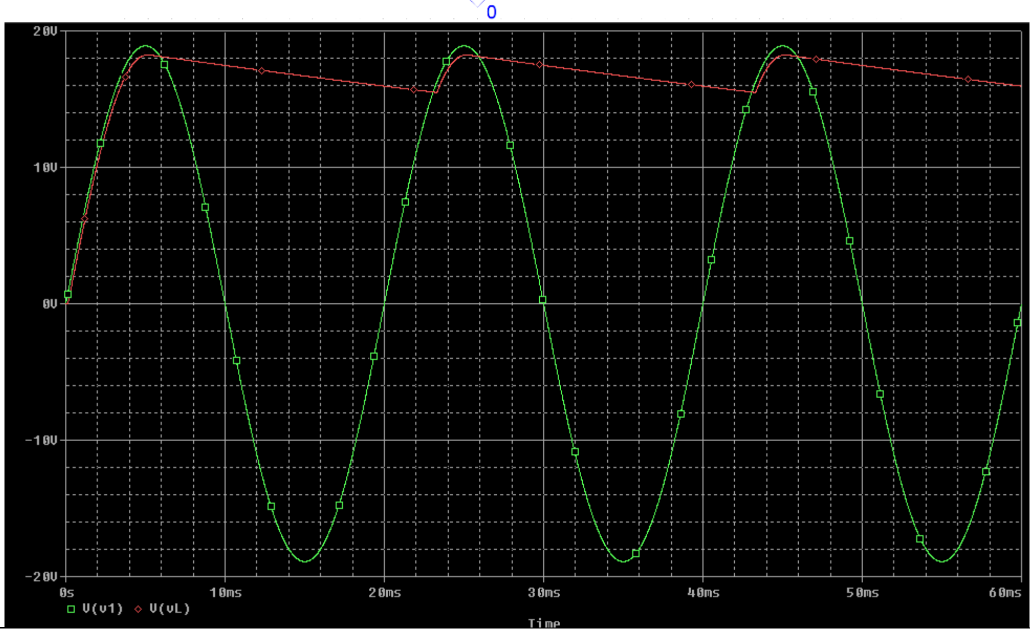
CASE I



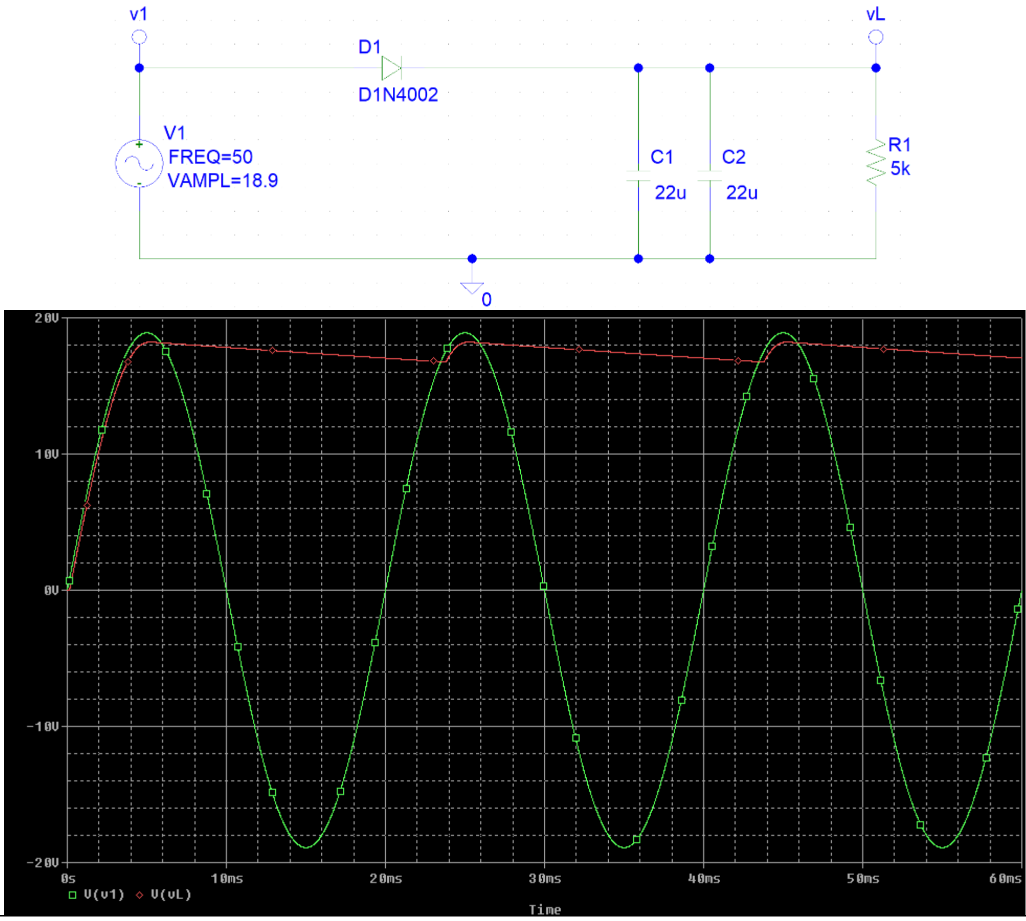


CASE II

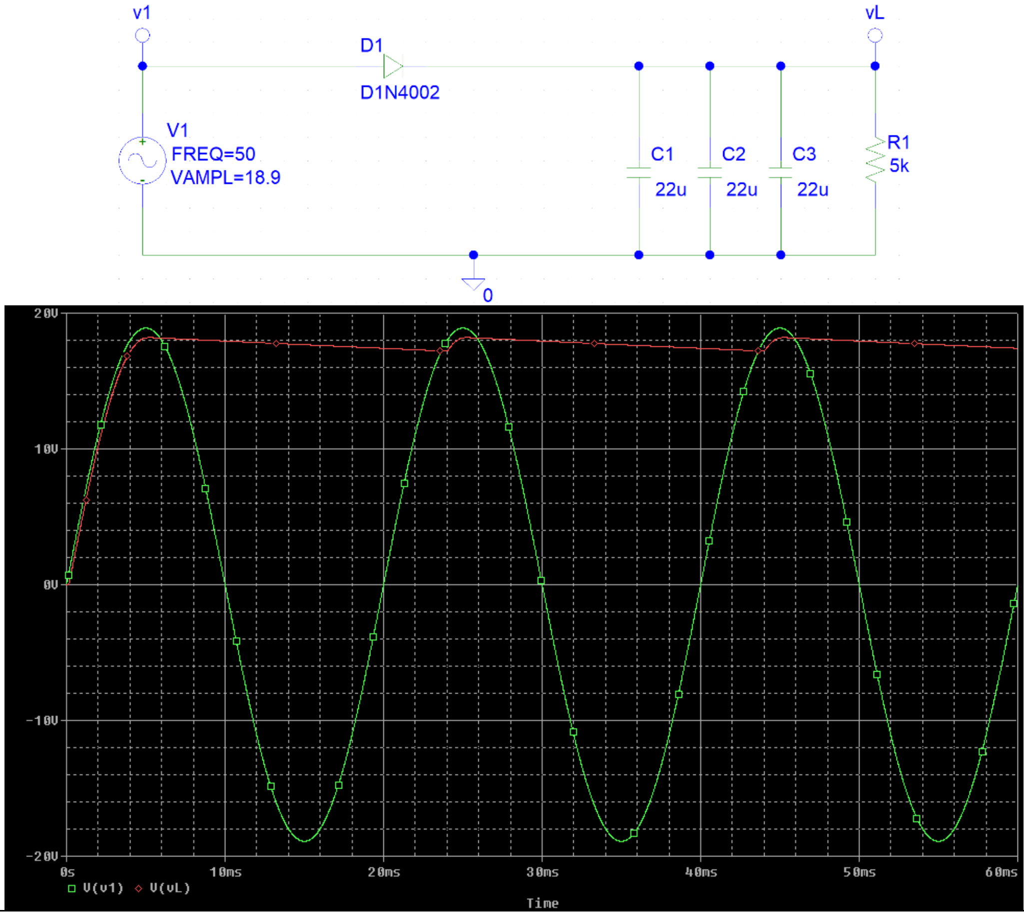




CASE III



CASE IV



❖ *Tables*

▪ *Experimental*

CAPACITORS	V_{2m}	Δv_L	V_{LDC}
0	18.9	-	5.80
1	18.7	1.88	17.76
2	18.7	1.11	18.15
3	18.7	0.74	18.33

▪ *Calculation*

CAPACITORS	Δv_L	V_{LDC}
0	-	6.02
1	3.44	17.18
2	1.72	18.04
3	1.15	18.33

❖ *Conclusion*

Following the experiments & calculations, we can conclude that with the increase in capacitors, the output DC voltage also increases and the ripple decreases, smoothening the DC waveform.