Faculty of Information Technology

Electrical Engineering Department

ANALOG ELECTRONICS

ENEE 236_Q1


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# ❖Table of Contents:

## ❖ Question1:

Design a rectifier with filter to provide a load (RL=0.75 kohm) with an average voltage equal to 30 Vdc with a ripple factor = ~7%,
Input voltage Vin is sinusoidal with 110Vrms, f=60 Hz: assume practical diodes perform the design using all three rectifier types:

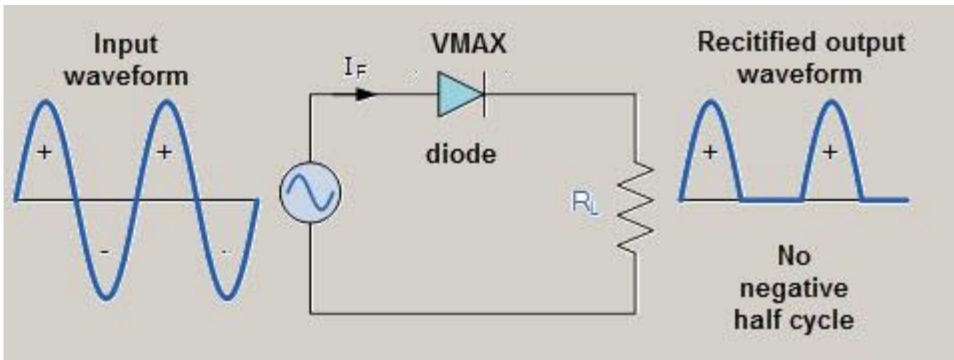
1. Half Wave rectifier
2. Bridge Full wave rectifier
3. Center tapped transformer full wave rectifier

Simulate the designed circuits usin Pspice student edition

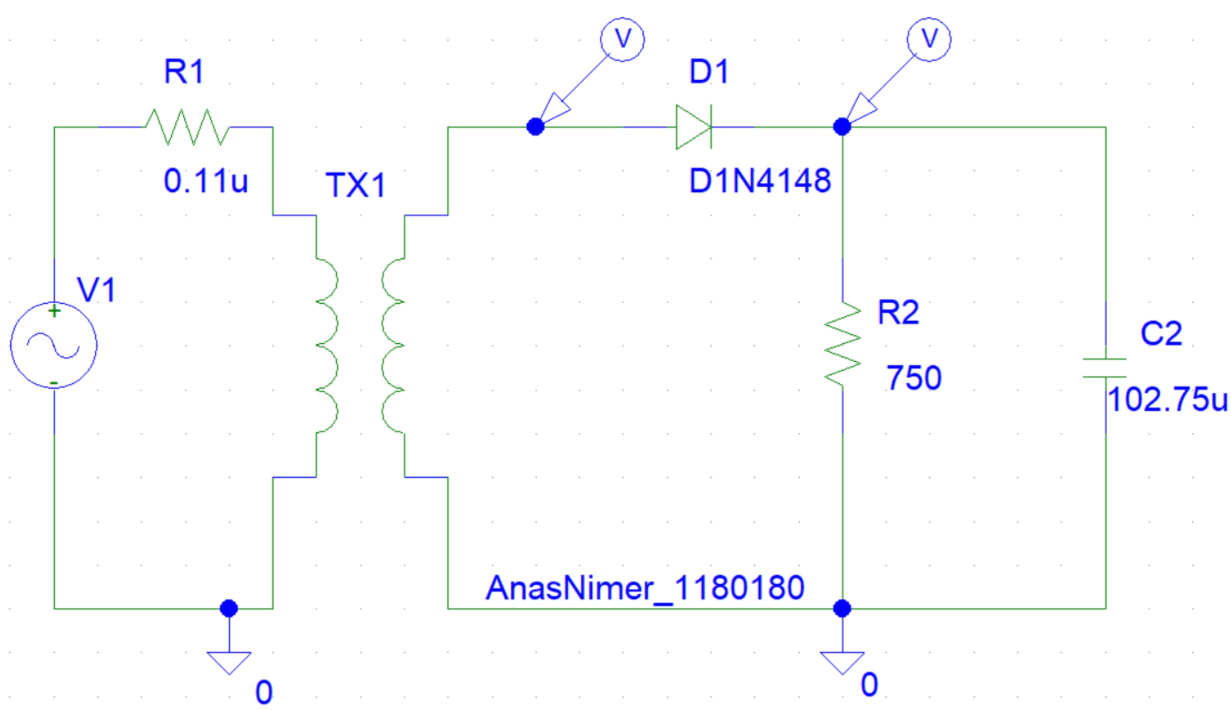
## ❖ The Work:

### 1. Half Wave rectifier:

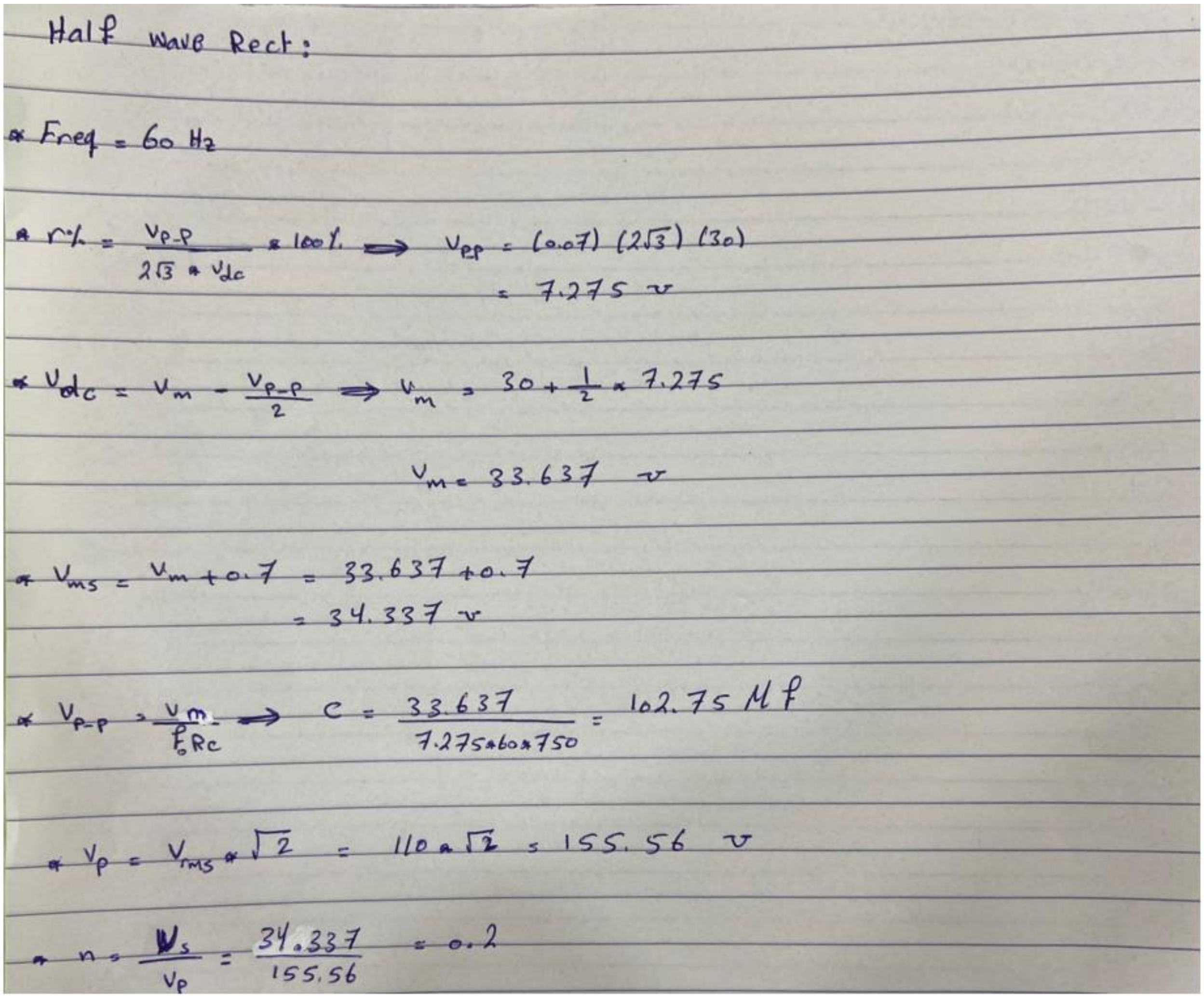
In Half wave rectifier during the positive half cycle, the diode is under forwarding bias condition and it conducts current to RL (Load resistance). A voltage is developed across the load, which is the same as the input AC signal of the positive half cycle [1].




Design ➔



## The Solution ➔



Half wave Rect:

* Freq = 60 Hz

* $r\% = \frac{V_{p-p}}{2\sqrt{3} * V_{dc}} * 100\% \Rightarrow V_{pp} = (0.07)(2\sqrt{3})(30)$

$= 7.275$ v

* $V_{dc} = V_m - \frac{V_{p-p}}{2} \Rightarrow V_m = 30 + \frac{1}{2} * 7.275$

$V_m = 33.637$ v

* $V_{ms} = V_m + 0.7 = 33.637 + 0.7$

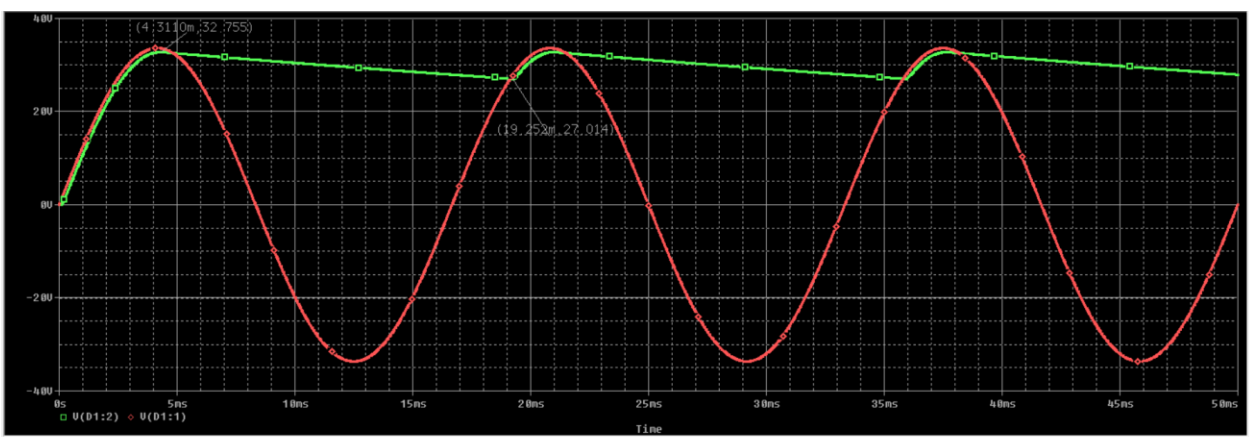
$= 34.337$ v

* $V_{p-p} = \frac{V_m}{f_o R c} \Rightarrow C = \frac{33.637}{7.275 * 60 * 750} = 102.75$ M f

* $V_p = V_{rms} * \sqrt{2} = 110 * \sqrt{2} = 155.56$ v

* $n = \frac{V_s}{V_p} = \frac{34.337}{155.56} = 0.2$

## Simulate ➔



## The Solution ➔

* $V_{p-p} = y_{max} - y_{min} = 32.755 - 27.014$

$= 5.741 \ v$

* $V_{Rms} = \frac{V_{p-p}}{2\sqrt{3}} = \frac{5.741}{2\sqrt{3}} = 1.657 \ v$

* $V_{dc} = V_m = \frac{V_{p-p}}{2} = 32.755 - \frac{5.741}{2}$

$= 29.88 \ v$

* $r\% = \frac{V_{rms}}{V_{dc}} * 100\% = 5.546\%$

* we need to find $L_1$ and $L_2$

suppose $L_2 = 1 \ mH$

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \sqrt{\frac{L_1}{L_2}}$$

$$\frac{1}{n} = \sqrt{\frac{L_1}{L_2}}$$

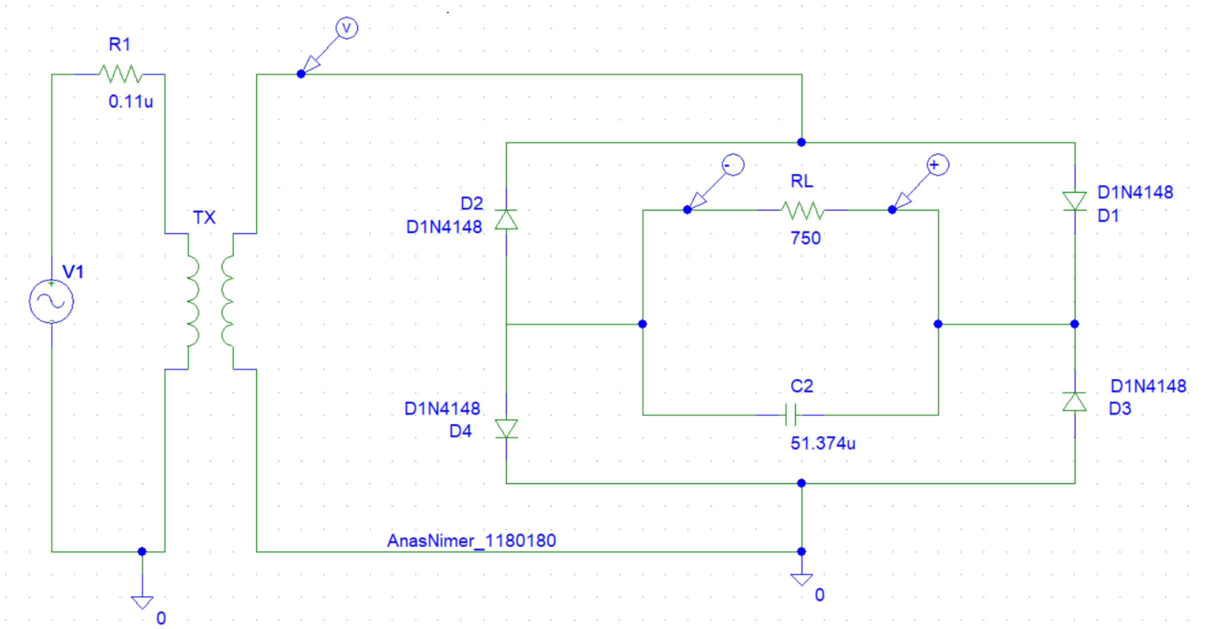
$$\frac{1}{0.2} = \sqrt{\frac{L_1}{1}} \Rightarrow L_1 = 21.4 \ mH$$

## 2. Bridge Full Wave rectifier:

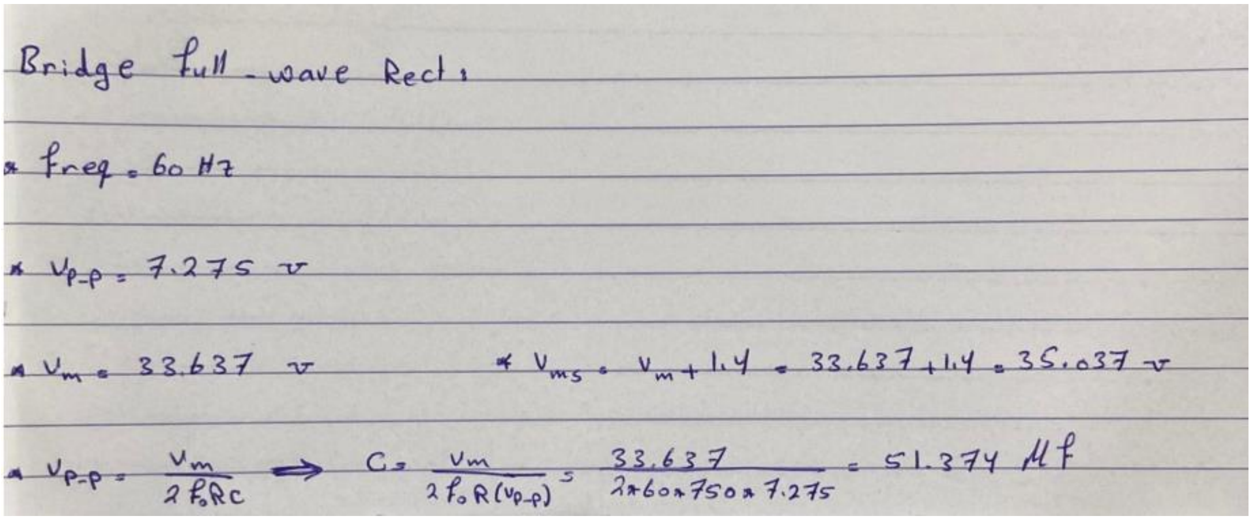
A diode bridge is an arrangement of four (or more) diodes in a bridge circuit configuration that provides the same polarity of output for either polarity of input.

When used in its most common application, for conversion of an alternating-current (AC) input into a direct-current (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input [2].

## Design ➔



## The Solution ➔



Bridge full-wave Rect:

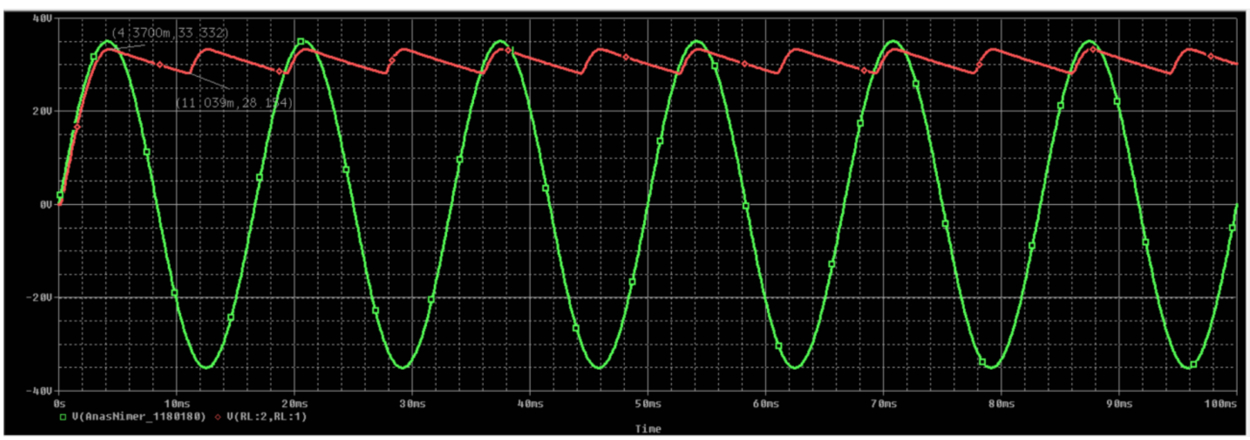
* freq = 60 Hz

* $V_{p-p} = 7.275$ v

* $V_m = 33.637$ v    * $V_{ms} = V_m + 1.4 = 33.637 + 1.4 = 35.037$ v

* $V_{p-p} = \frac{V_m}{2 f_o R C} \Rightarrow C = \frac{V_m}{2 f_o R (V_{p-p})} = \frac{33.637}{2 * 60 * 750 * 7.275} = 51.374$ μf

## Simulate ➔



The Solution ➔

* $V_{p-p} = y_{max} - y_{min} = 33.332 - 28.154$

  $= 5.178$ v

* $V_{rms} = \frac{V_{p-p}}{2\sqrt{3}} = \frac{5.178}{2\sqrt{3}} = 1.495$ v

* $V_{dc} = V_m - \frac{V_{p-p}}{2} = 33.332 - \frac{5.178}{2}$

  $= 30.743$ v

* $r\% = \frac{V_{rms}}{V_{dc}} \times 100\% = \frac{1.495}{30.743} \times 100\% = 4.862\%$

* we need to find $L_1$ and $L_2$

* suppose $L_2 = 1\ mH$

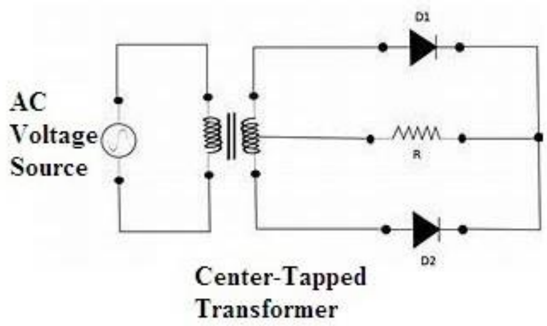
* $\frac{V_p}{V_s} = \sqrt{\frac{L_1}{L_2}}$

  $\frac{155.56}{35.037} = \sqrt{\frac{L_1}{1}} \Longrightarrow L_1 = 19.7\ mH$

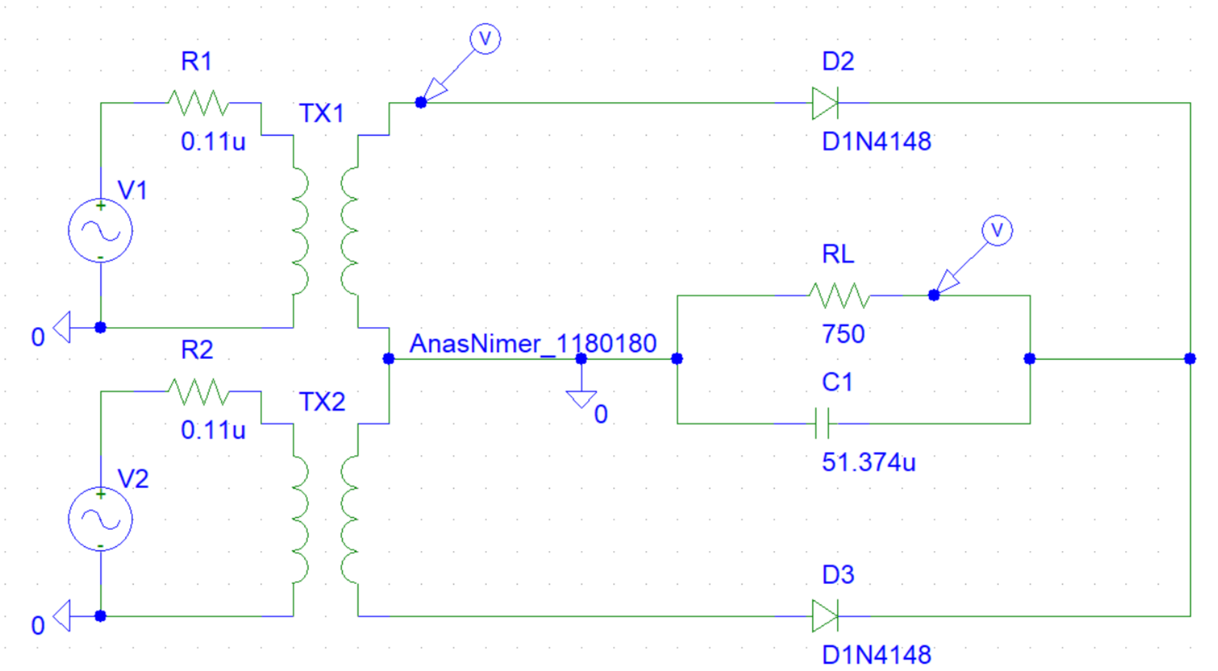
## 3. Center tapped Full Wave rectifier:

A rectifier that utilizes both the cycles during rectification is said to be a full wave rectifier. If the rectification is done by the usage of the center tapped transformer in the full wave. It is said to be a center tapped full wave rectifier [3].

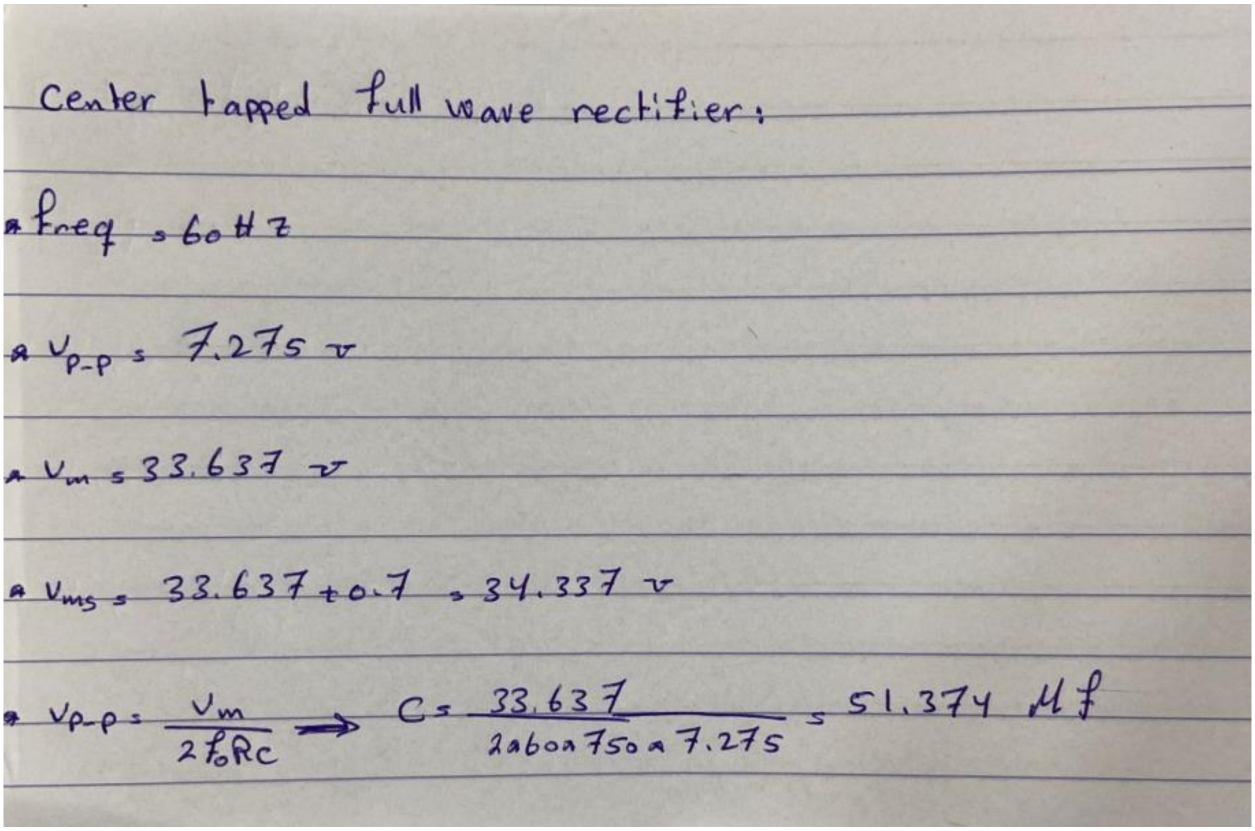
A full wave rectifier based on center tap consists of two diodes in it as well as a center tapped transformer along with that a resistive load is connected across it [3].




## Design ➔



The Solution ➔



Center tapped full wave rectifier:

* freq = 60 Hz

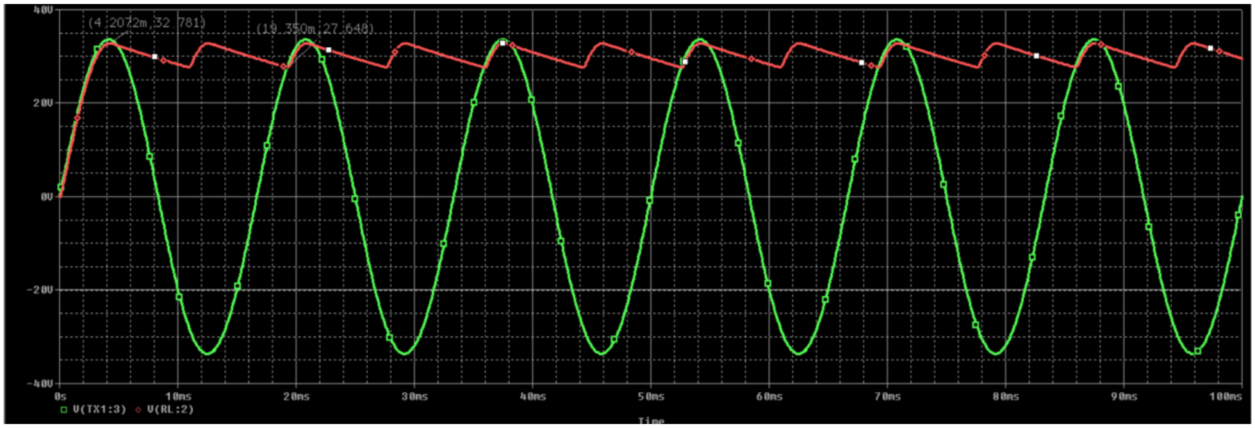
* $V_{p-p} = 7.275\ v$

* $V_m = 33.637\ v$

* $V_{ms} = 33.637 + 0.7 = 34.337\ v$

* $V_{p-p} = \frac{V_m}{2 f_o R C} \Longrightarrow C = \frac{33.637}{2 \times 60 \times 750 \times 7.275} = 51.374\ \mu f$

Simulate ➔



The Solution ➔

* $V_{p-p} = y_{max} - y_{min}$

$= 32.781 - 27.640$

$= 5.141\ v$

* $V_{rms} = \frac{V_{p-p}}{2\sqrt{3}} = \frac{5.141}{2\sqrt{3}} = 1.484\ v$

* $V_{dc} = V_m - \frac{V_{p-p}}{2} = 32.781 - \frac{5.141}{2}$

$= 30.21\ v$

* $r\% = \frac{V_{rms}}{V_{dc}} * 100\% = \frac{1.484}{30.21} * 100\% = 4.912\ \%$

# ❖ Reference:


[1] : https://www.elprocus.com/half-wave-rectifier-circuit-working-principle-and-characteristics-2/.

[2]: https://en.wikipedia.org/wiki/Diode_bridge.

[3]: https://www.watelectronics.com/center-tapped-full-wave-rectifier-circuit-working-equations/.