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Research Project

In fulfillment of the requirements of

Department	Electrical
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Course code	ECO 345

Title: -

Design of one phase full wave controlled rectifier

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Examiners committee	Signature

Project objectives

Designing of Full wave controlled rectifier to convert 220 one phase Ac voltage to 110 Dc using thyristors as controlled switch.

Abstract

We built our circuit using bridge configurations, Along with using following components:

1 - Transformer

2 - 4 Thryistors

3 - Resistive load

4 – 2 Switch gate block (SCR Firing circuit)

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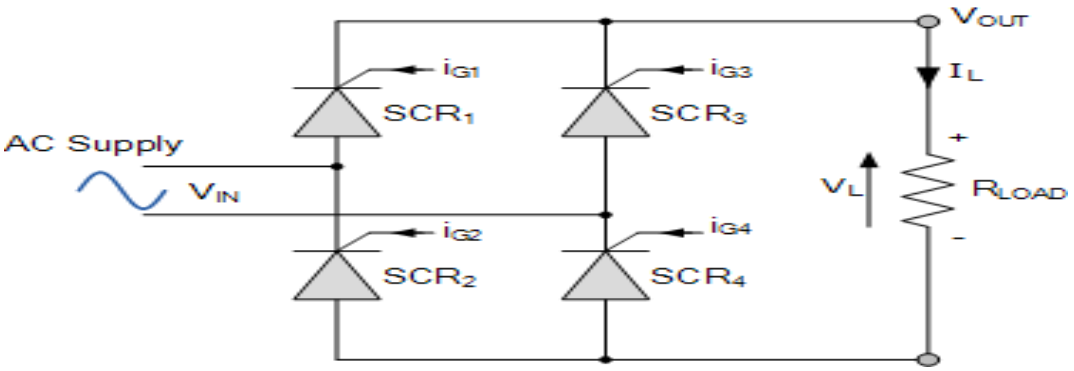
Introduction

Structure of fully controlled bride rectifier:



In this bridge configuration, the Dc average load voltage is controlled by using 4 Thyristors in total, 2 per half-cycle. Thyristors SCR1 and SCR4 are fired together during the positive half-cycle, from 0^0 to 180^0, while Thyristors SCR3 and SCR2 are fired during the negative half-cycle, from 180^0 to 360^0.

During the mode of continuous conduction of operation the four SCRs are constantly being switched as alternate pairs to maintain the average or equivalent DC output voltage. Output voltage can be fully controlled by varying the SCR firing delay angle (α)

To allow conduction of current. To ensure simultaneous firing, thyristors T1 and T4 use the same firing signal. Alternatively, thyristors T2 and T3 must be fired simultaneously during the negative half wave of the source voltage so T1 T3 or T2 T4 cannot conduct simultaneously. Therefore, the only possible conduction modes when the current can flow are T1 T4 and T2 T3.

Mathematical model

- $V_{dc} = [V_m / \pi] [1+\cos(\alpha)]$
- $110 = [\sqrt{2} * (220) / \pi] [1+\cos(\alpha)]$
- $\alpha = 83.64^0$ (The used firing angle in the thyristor to achieve 110V output voltage)
- $V_{orms} = [V_m][0.5 - \alpha/2\pi + \sin(2\alpha)/4\pi]^{0.5} = 166.151V$
- Using R_{load} of value equal to 10 ohms.

- $I_{dc} = [V_{dc}/R] = [V_m/\pi R] [1+\cos(\alpha)] = [110/10] = 11A$

- $I_{rms} = V_{rms}/R = [V_m/R] [0.5 - \alpha/2\pi + \sin(2\alpha)/4\pi]^{0.5}$

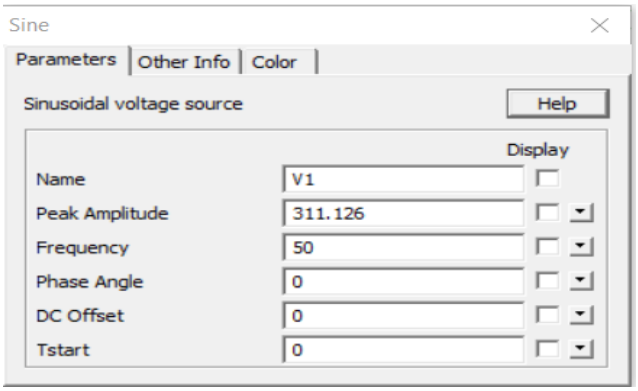
- $= [(220\sqrt{2})/(10)] [0.5 - 83.64^0(\pi/180^\circ)/2\pi + \sin(2*83.64^0)/4\pi]^{0.5} = 16.615A$

- PIV(Peak inverse voltage) = $V_m = 220\sqrt{2} = 311.13V$

Design & Simulation

Using PSIM:

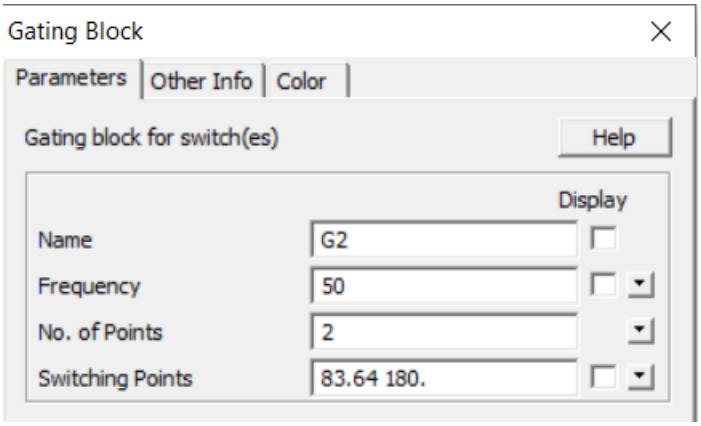
First setting up ac value:



Peak amplitude = 220V *√2 = 311.126V

Setting up switch gate block responsible for scr 1 & scr 3:

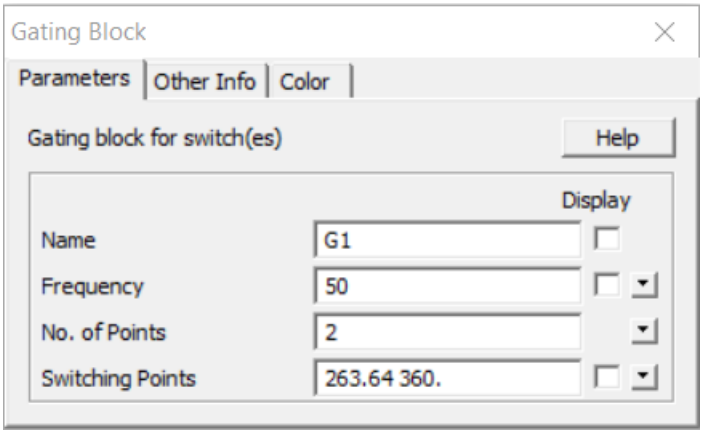
Using firing angle of 83.64 to turn on the Thyristors(T1 and T3) in first 180 degree.



Switch gate block 2 Configurations:

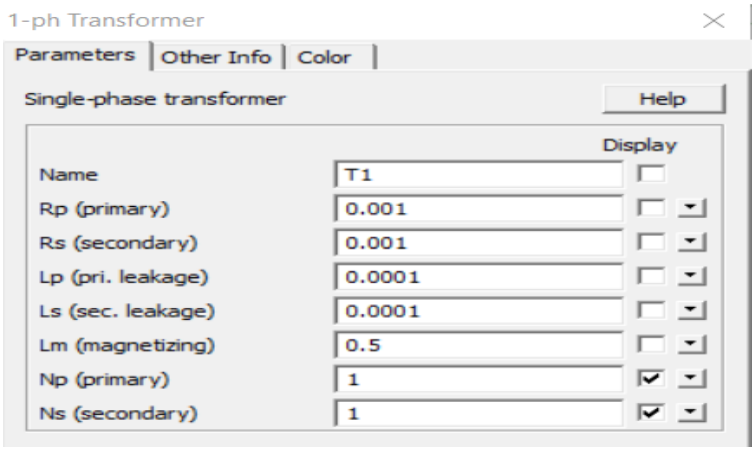
Responsible for Scr2 & Scr4

Adding 180 to 83.64 since Scr2 and Scr4 Are expected to be working in the Negative half cycle of signal (Range from 180 ~360).

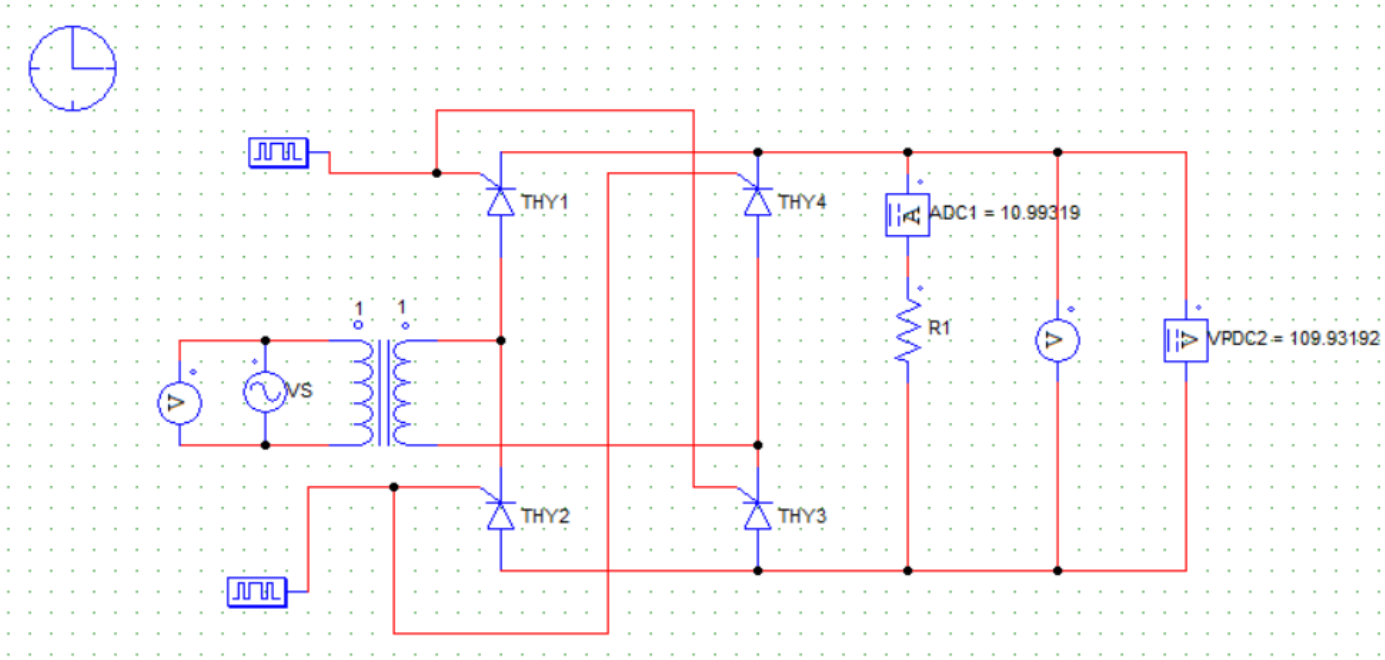


Transformer configurations:

Transformer is used with 1 : 1 settings for Isolation.

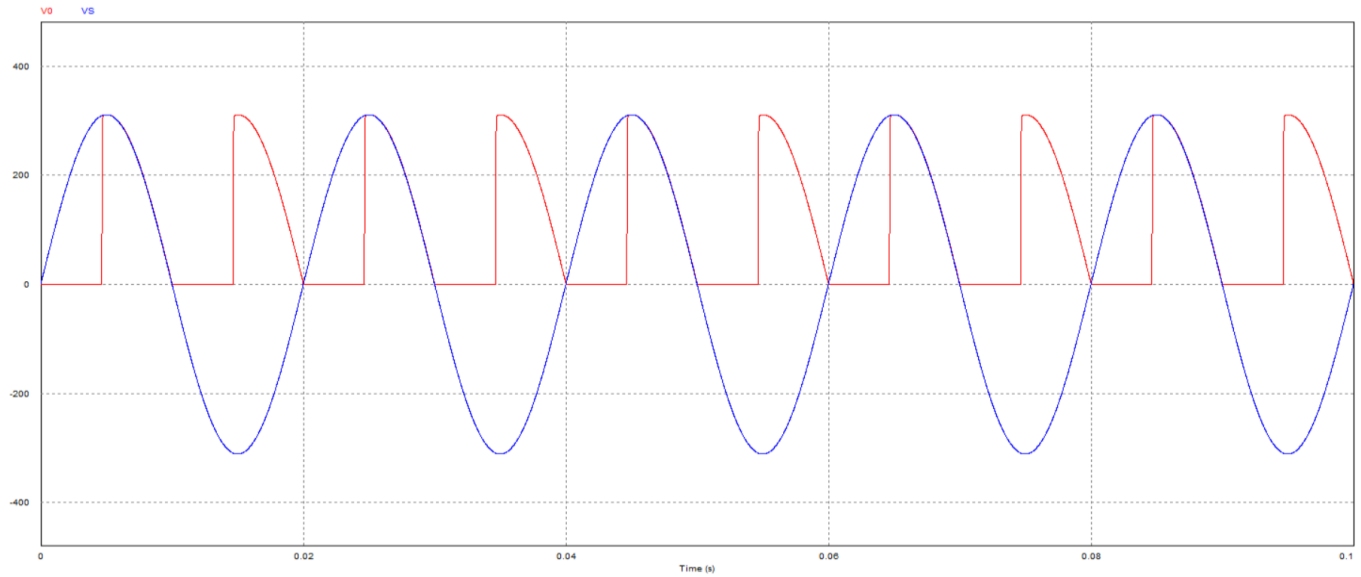


Circuit design:



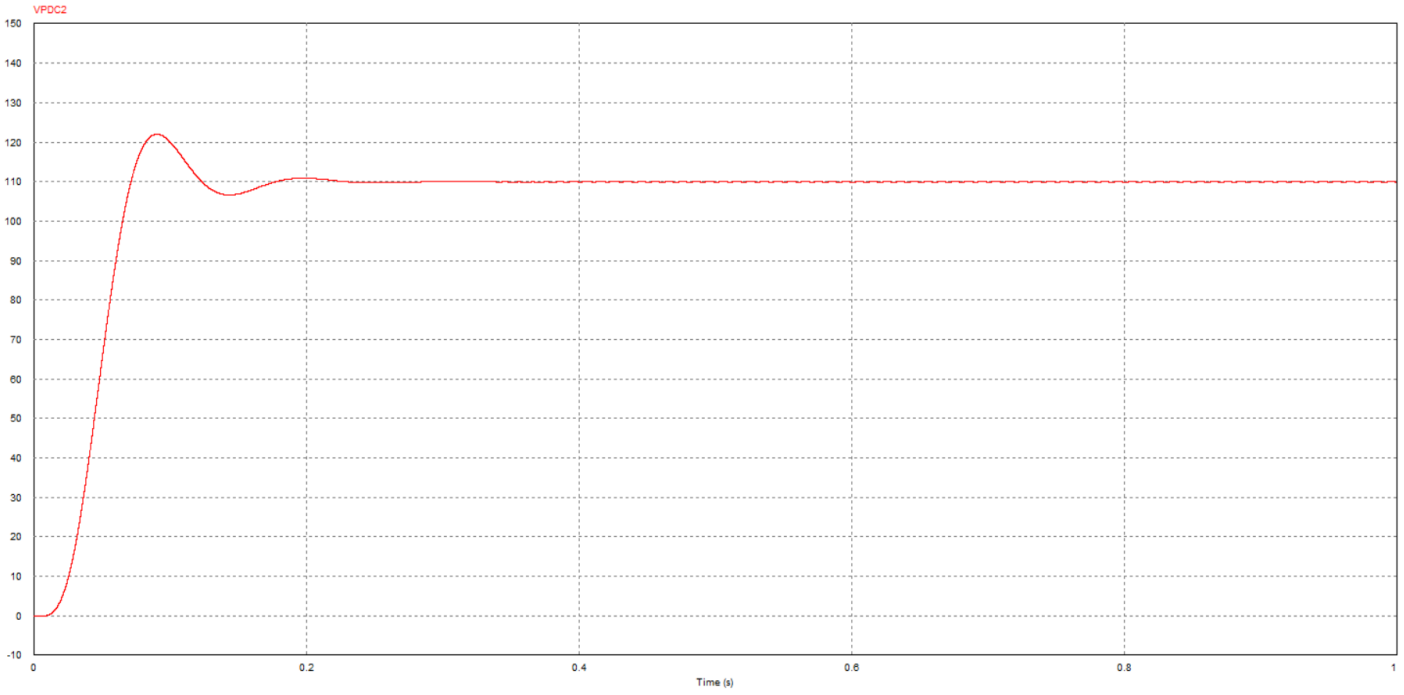
Results

Vs/Vo waveform:



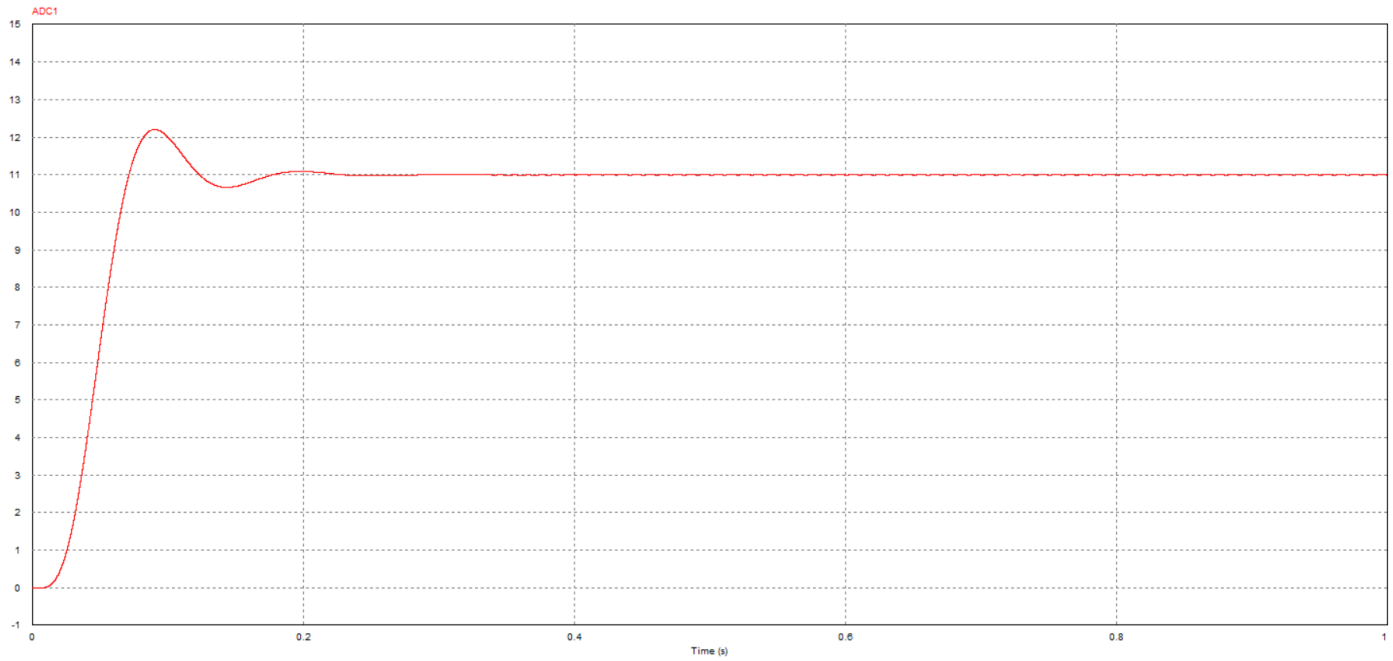
Vdc:

Vdc = 109.93192V

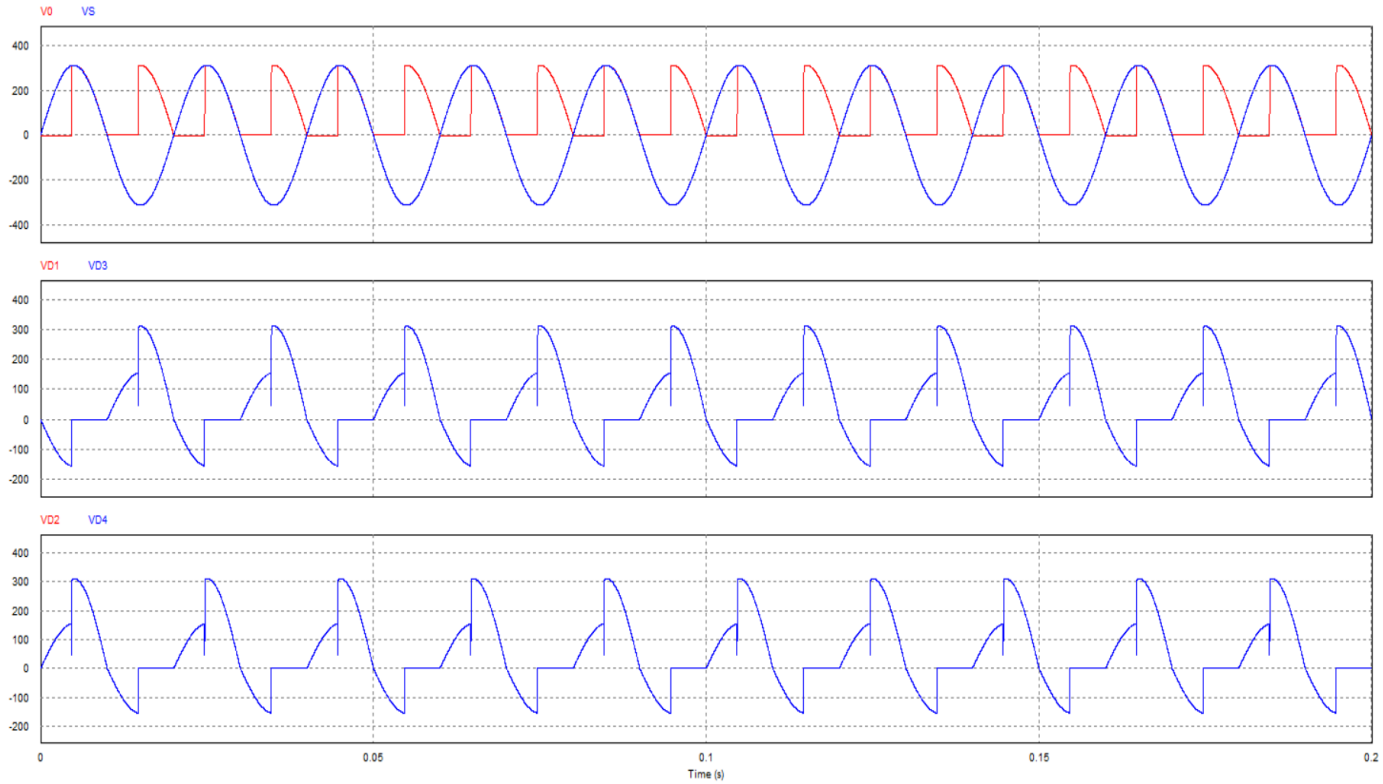


Idc:

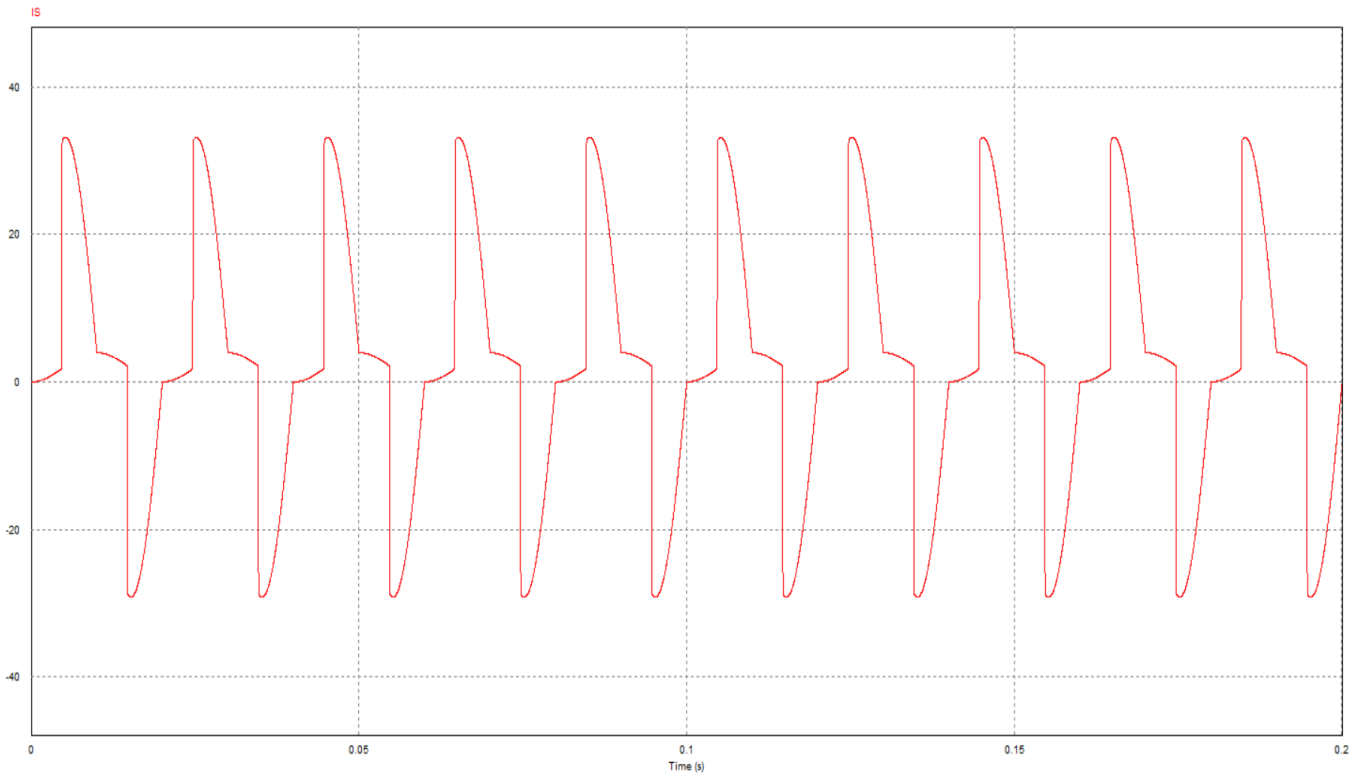
Idc = 10.99319 A



Diode voltages:



Is:



Conclusions

In this report we made one phase controlled full wave rectifier converts 220V AC to 110V DC by using thyristor and by using PSIM simulation tool we could achieve 109.93V approx. 110V in continuous operation mode while having the expected V_0 wave form.