**Q2)**

**Part a)**

**Single Phase Rectifier Fully Controlled**

Input voltage is given as rms. So peak value of the input voltage is , which is equal to 324.3 V. After that, from the integral calculations, average output voltage is calculated, as . However, in addition topology has extra losses due to commutation, . From the equation loss due to commutation is 4 \* 50 \* 2 \* 0.01 = 4 V. So, total voltage is 203.7 \* cos(a). For getting 40 A, output average voltage should be 160 V. For getting 160 V DC output, a value calculated as, a = arccos(160/203.7) = 38.2359 degree.

metin, diyagram, çizgi, öykü gelişim çizgisi; kumpas; grafiğini çıkarma içeren bir resim

Açıklama otomatik olarak oluşturuldu

*Figure 1. Voltage Waveform of RL Load Single Phase Fully Controlled Rectifier*

*Full Wave Thyristor Rectifier*

Then, design of topology is implemented.

diyagram, teknik çizim, plan, şematik içeren bir resim

Açıklama otomatik olarak oluşturuldu

*Figure 2. Matlab Simulink Schematic for Fully Controlled Rectifier*

After creating topology, pulse generator is adjusted according to our calculations. We found a degree as 38.2359 degree. So, we must create a delay for firing angle. We calculate firing angle from equation, , from the equation delay is found as 0.0021244 s. So, this delay is implemented to pulse generator 1 and 3. Then, delay on the pulse generators 2 and 4 are adjusted as (0.00212 + 0.01) s, because this current way is used second interval of one full period. So, extra 1/100 s coming from this inference.

metin, ekran görüntüsü, sayı, numara, yazı tipi içeren bir resim

Açıklama otomatik olarak oluşturuldu

*Figure 3. Pulse Generator Implementations for Fully Controlled Rectifier*

Then simulation was run, after adjusting.

taslak, çizgi, dikdörtgen, diyagram içeren bir resim

Açıklama otomatik olarak oluşturuldu

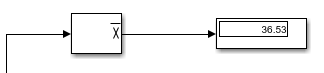
*Figure 4. Average Output Voltage of Fully Controlled Rectifier*

çizgi, öykü gelişim çizgisi; kumpas; grafiğini çıkarma, ekran görüntüsü, diyagram içeren bir resim

Açıklama otomatik olarak oluşturuldu

*Figure 5. Output Voltage Waveform of Fully Controlled Rectifier*

Results are given in Figure 4 and 5. Output average voltage is measured as 146.1 V. It is very similar to our theoretical calculations. However, because of the losses in the thyristors and voltage drop on the load inductor, some voltage drops can be seen.



*Figure 6. Average Output Current of Fully Controlled Rectifier*

Resulted average output current can be seen in Figure 6. From the calculation, . So, our theoretical calculations match with simulation results. Again, some non-idealities in the rectifier and voltage drop on load inductance, we see some small differences.

**Single Phase Rectifier Half Controlled**

For single phase rectifier half controlled, used diodes are work like Free-Wheeling Diode. So, output voltage cannot go below 0 V. It will stay at 0 V when voltage is exactly zero and jump to voltage when thyristors are fired. With this information, we made calculations.

diyagram, çizgi, öykü gelişim çizgisi; kumpas; grafiğini çıkarma içeren bir resim

Açıklama otomatik olarak oluşturuldu

*Figure 7. Average Voltage Waveform of Half Controlled Rectifier*

From this waveform, we can do calculations for getting 40 A output current. As we did previous part, our expected average voltage should be 160 V again. From the equation, , we understand that firing angle should be degree, and commutation loss is taking into account. After these calculations, same pulse generator formulas are implemented to pulse generator.

metin, ekran görüntüsü, sayı, numara, yazı tipi içeren bir resim

Açıklama otomatik olarak oluşturuldu

*Figure 8. Pulse Generator Implementations for Half Controlled Rectifier*

diyagram, metin, çizgi, plan içeren bir resim

Açıklama otomatik olarak oluşturuldu

*Figure 9. Matlab Simulink Schematic for Half Controlled Rectifier*

Afterwards, the simulation results were saved.

*çizgi, öykü gelişim çizgisi; kumpas; grafiğini çıkarma, diyagram, metin içeren bir resim

Açıklama otomatik olarak oluşturuldu*

*Figure 10. Output Voltage Waveform of Half Controlled Rectifier*

taslak, diyagram, çizgi, dikdörtgen içeren bir resim

Açıklama otomatik olarak oluşturuldu

*Figure 11. Average Output Current of Half Controlled Rectifier*

taslak, diyagram, çizgi, dikdörtgen içeren bir resim

Açıklama otomatik olarak oluşturuldu

*Figure 12. Average Output Voltage of Half Controlled Rectifier*

From the results, our theoretical expectations are very similar with simulation results. They have small deviations; these deviations may cause from many reasons. Diodes and thyristors are not ideal. They have forward voltages and leakage currents. In addition, they have internal resistances. In addition, expected output voltage is not exactly same, 12.5% deviation is available. When we calculate total resistance at output, which is , this value is not expected.

**Part b)**

**Single Phase Rectifier Half Controlled**

çizgi, diyagram, öykü gelişim çizgisi; kumpas; grafiğini çıkarma, paralel içeren bir resim

Açıklama otomatik olarak oluşturuldu

Half Controlled

öykü gelişim çizgisi; kumpas; grafiğini çıkarma, çizgi, diyagram, ekran görüntüsü içeren bir resim

Açıklama otomatik olarak oluşturuldu

Fully Controlled