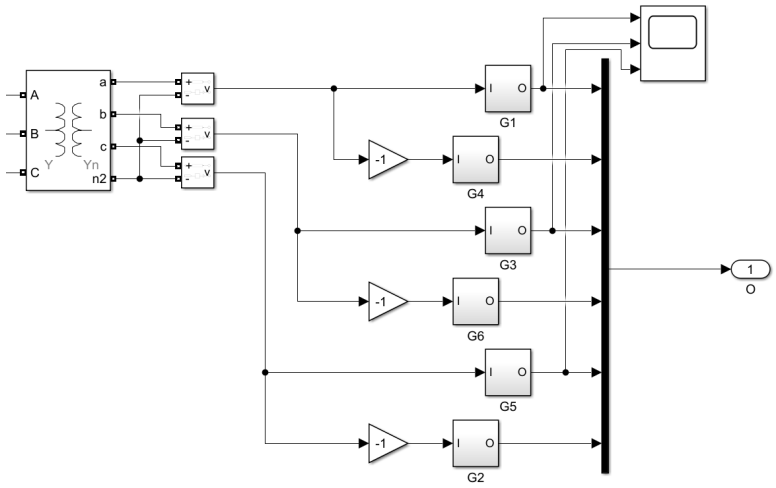
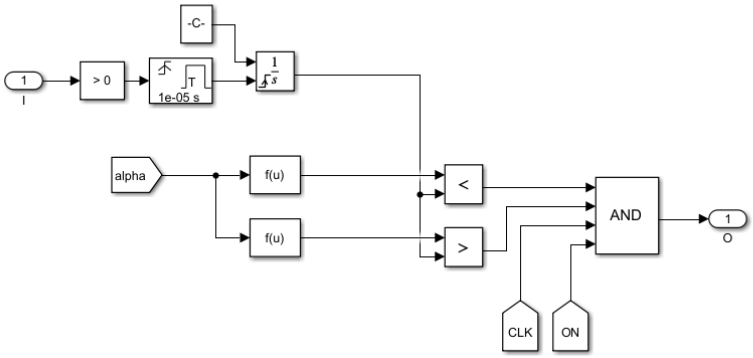
Mansi Uniyal
19EE10039

PART - A

Triggering Circuit:

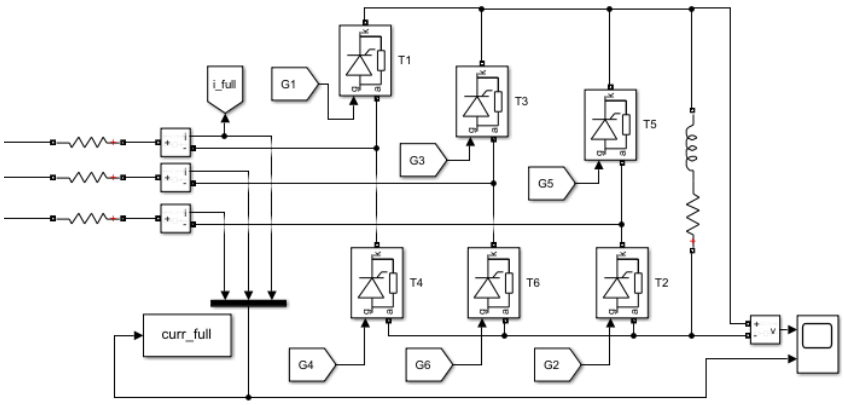


G1:



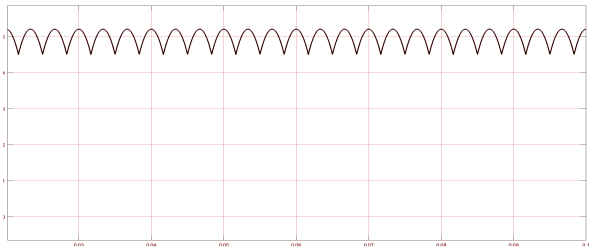
PART - B

Circuit Diagram:



1.

Vrect=(3*sqrt*(3)/pi)*Vm*cos(a)
Id.R=(3*sqrt*(3)/pi)*Vm*cos(a)
Id=5A
a=0
Vm=220*sqrt(2/3)
5*R=220*sqrt(2/3)*(3*sqrt*(3)/pi)*cos(0)
R=59.42 ohm

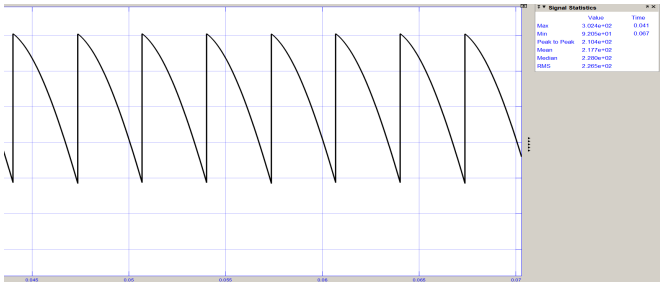

Average load current = 4.972 A

2.

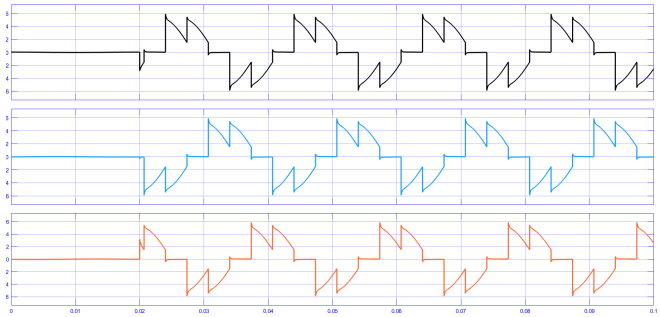
Vrect=(3*sqrt*(2)/pi)*220*cos(a)=220
cos(a)=pi/3*sqrt(2) = 0.7405
a=42.23 deg

3.

Output Voltage:


Average output voltage = 217.7 V

AC side currents:

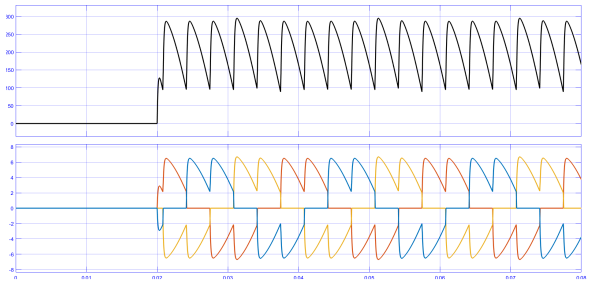


4.

R = 59.421 Ω

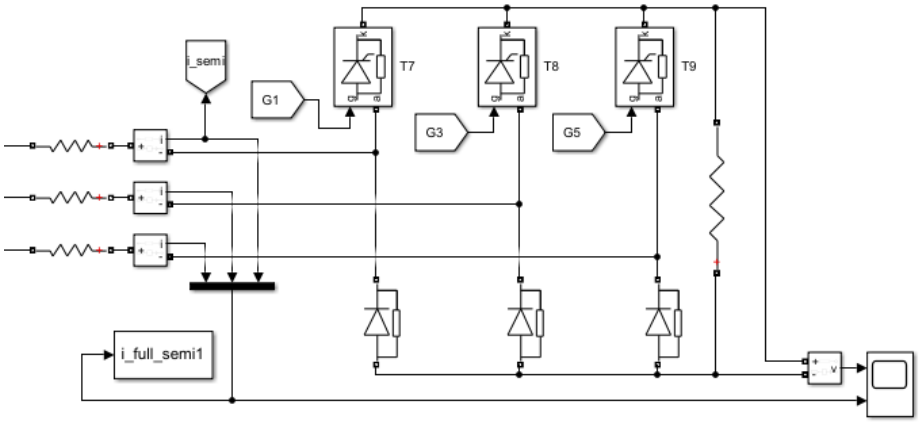
Alpha (degree)	Average output Voltage (V)	AC side current (RMS) (A)
0	295.5	4.06
15	284.8	3.93
30	255.2	3.57
45	208.54	3.00
60	146.3	2.30
75	87.32	1.57
90	39.20	0.87

5.



PART - C

Circuit Diagram:



1.

Vrect=(3*sqrt(3)/(2*pi))*Vm*(1+cos(a))=Id*R

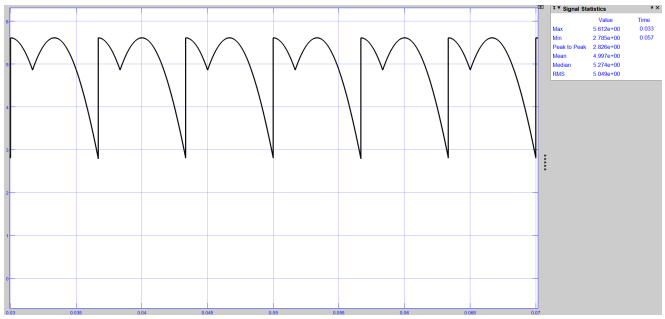
Id=5A

a=30 deg

Vm=220*sqrt(⅔)

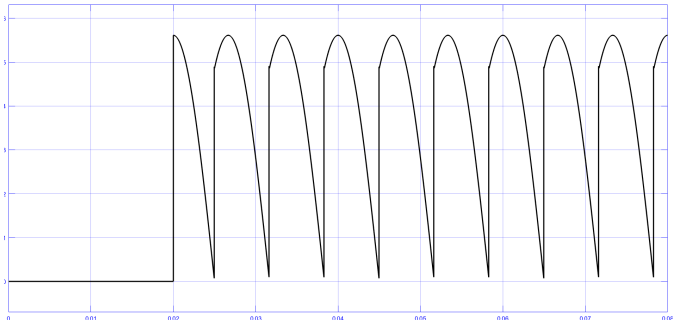
5*R=(3*sqrt(3)/(2*pi))*220*sqrt(⅔)*(1+cos(a))

R=55.44 ohm

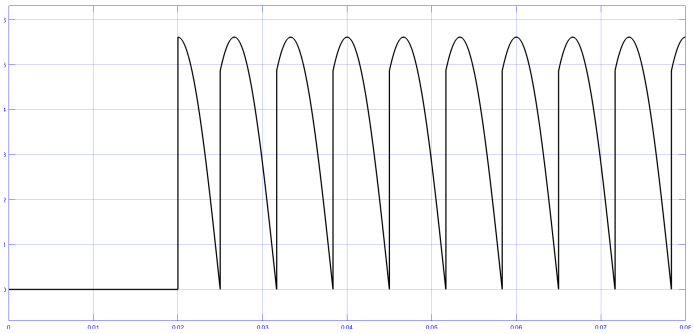

Average Load current = 4.997 A

2.

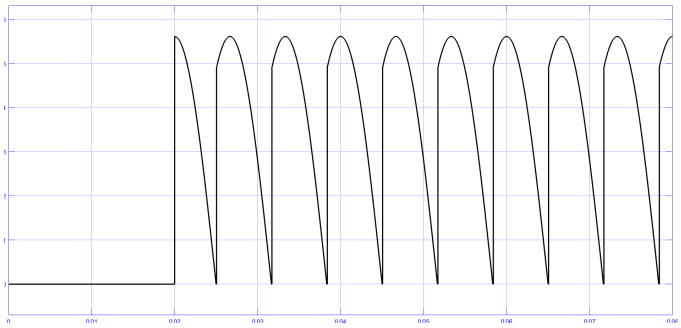
Load current at alpha = 59°



Load current at alpha = 60°

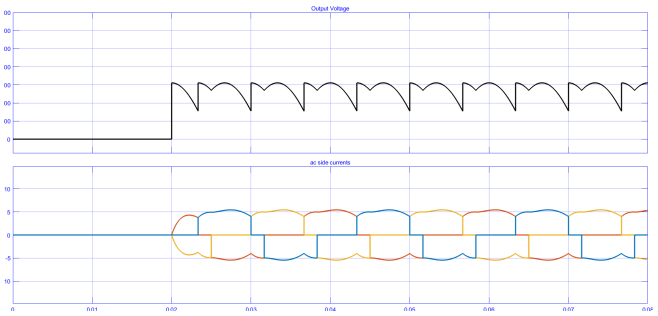


Load current at alpha = 61°



Hence, the load current becomes discontinuous as soon as it crosses alpha = 60°

3.



Average output voltage = 277.1 V

4.

R = 55.44 Ω

Alpha (degree)	Average output Voltage (V)	AC side current (RMS) (A)
0	296.8	4.31
15	292.1	4.23
30	277.3	4.01
45	254.3	3.68
60	223.1	3.28

75	185.2	2.86
90	148.0	2.42

PART - D

Parameter	Full-controlled Converter	Semi-controlled Converter
AC side currents (RMS)	4.08	4.08
Fundamental component of the AC side currents (RMS)	3.89	3.86
THD (%) of the AC side currents	31.13	34.10
Input power factor	0.922	0.913
Fundamental active power (W)	2025.60	2009.41
Fundamental reactive power (VAr)	542.7	538.4

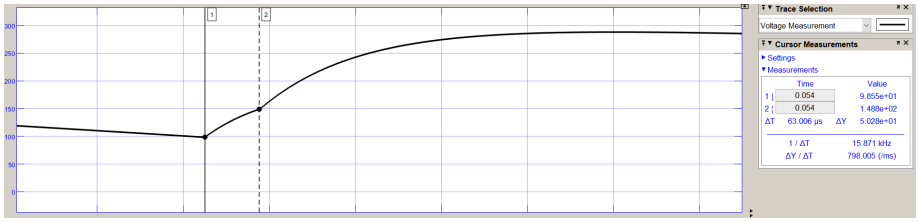
Discussion Questions:

1. Consider an ideal three-phase full-controlled converter with an R load. Obtain the expression of the average output voltage (for $\alpha \in [0, \pi/2]$).

Avg output voltage of ideal 3 phase fully controlled converter with R load:
(i) a in [0,pi/3]
Vrect=(3/pi)*integral(sqrt(3)*Vm*sin(wt+(pi/6))) ...from limit a+pi/6 to a+pi/2
=3sqrt(3)*Vm*cos(a)/pi

(ii) a in [pi/6,pi/2]
Vrect=(3/pi)*integral(sqrt(3)*Vm*sin(wt+(pi/6))) ...from limit a+pi/6 to pi
=3sqrt(3)Vmcos(a+pi/3)/pi

2. Refer to Part B(5), what is the commutation overlap angle μ? What is the average output DC voltage?



: ΔT = 63.006 µs

Commutation overlap angle = (63.01* 10^-3 / 3.33) x 180 deg = 3.41 deg
Average DC voltage = 212.1 V

3. Refer to Part D, compare the distortion factor of the two converters. Why is the distortion factor less in the case of the semi-controlled rectifier?

Distortion factor of three-phase fully controlled AC to DC converter = I_1/I = (3/pi) = 0.955
Distortion factor of three-phase semi-controlled AC to DC converter = I_1/I = √(6/pi(pi-a)) x cos(a/2)= 0.807 for a = π/12.

For a semi-controlled rectifier, the diodes allow more harmonics in the output. That is why the distortion factor is less for semi-controlled AC to DC converter.