JAIPUR INSTITUTE OF TECHNOLOGY GROUP OF INSTITUTIONS, JAIPUR

LIST OF EXPERIMENTS

1   Single phase ac voltage controller

2   Resonant pulse commutation circuit

3   Three phase full converter using rl&e loads

4   Impulse commutation circuit

5   Three phase inverter with pwm controller

6   Single phase full converter

7   Three phase half controlled bridge converter

8   Single phase cycloconverter

9   Single phase half controlled bridge converter

10   Single phase fully controlled bridge converter

4   Text and Reference Books:

T1. M.D Singh & K.B. Kanchandhani *"Power Electronics"* Tata Mc Graw – Hill Publishing Company, 2007

T2. M.H. Rashid "Power Electronics: Circuits, Devices and Applications" Prentice Hall of India, 2nd

REFERENCE BOOKS

R1.   Vedam Subramanyam *"Power Electronics"* New Age International (P) Limited, Publishers.

R2 : V.R. Murthy "Power Electronics" 1st Edition 2005, Oxford University Press R3
: P.C. Sen *"Power Electronics"* Tata Mc Graw-Hill Publishing

5. SESSION PLAN

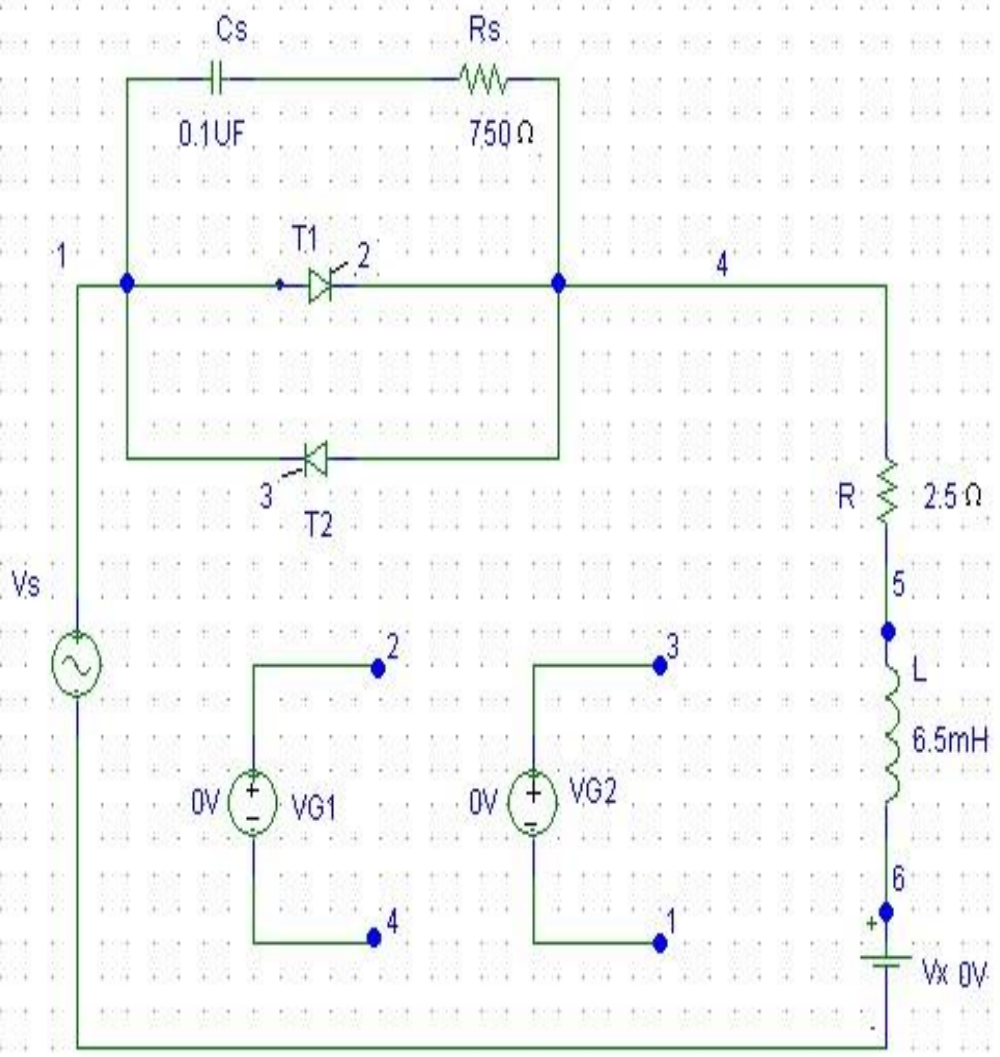| S.no	Name of the experiment	Week of Experiment
1	Single phase ac voltage controller	Week #1
2	Resonant pulse commutation circuit	Week #2
3	Three phase full converter using rl&e loads	Week #3
4	Impulse commutation circuit	Week #4
5	Three phase inverter with pwm controller	Week #5
6	Single phase full converter	Week #6
7	Three phase half controlled bridge converter	Week #7
8	Single phase cycloconverter	Week #8
9	Single phase half controlled bridge converter	Week #9
10	Single phase fully controlled bridge converter	Week #10

6 Experiment write up

6.1 SINGLE PHASE AC VOLTAGE CONTROLLER

EXP NO:

Date:

Aim: To analyze the simulation of single phase ac voltage controller.

Software Required: PSPICE (Personal Computer Simulated Program with
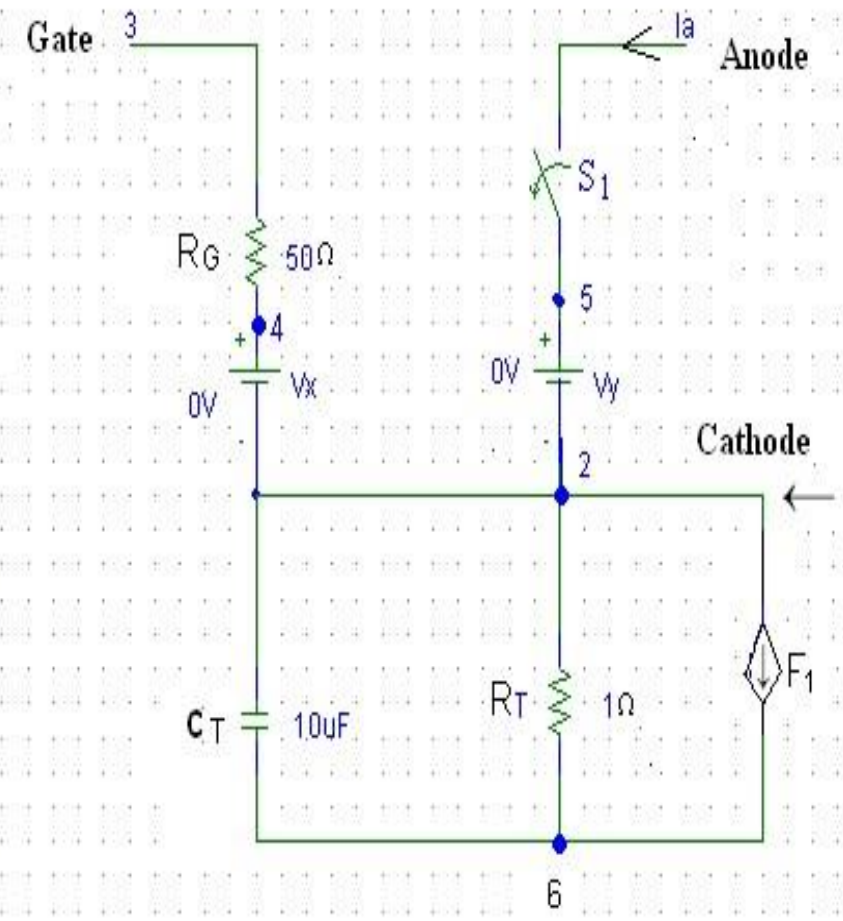
Integrated Circuit Emphasis.

Program:

```
VS 1 0 SIN(0V 169.7V 60HZ)
VG1 2 4 PULSE(0V 10V 4166.7US 1NS 1NS 100US 16666.67US)
VG2 3 1 PULSE(0V 10V 12500.0US 1NS 1NS 100US 16666.67US)
R 4 5 2.5
L 5 6 6.5MH
VX 6 0 DC 0V
CS 1 7 0.1UF
RS 7 4 750
XT1 1 4 2 4 SCR
XT2 4 1 3 1 SCR
.SUBCKT SCR 1 2 3 2
S1 1 5 6 2 SMOD
RG 3 4 50
VX 4 2 DC 0V
VY 5 2 DC 0V
RT 2 6 1
CT 6 2 10UF
F1 2 6 POLY(2) VX VY 0 50 11
.MODEL SMOD VSWITCH(RON=0.01 ROFF=10E+5 VON=0.1V VOFF=0V)
.ENDS SCR
.TRAN 10US 33.33MS
.PROBE
.FOUR 60HZ V(4)
.END
```
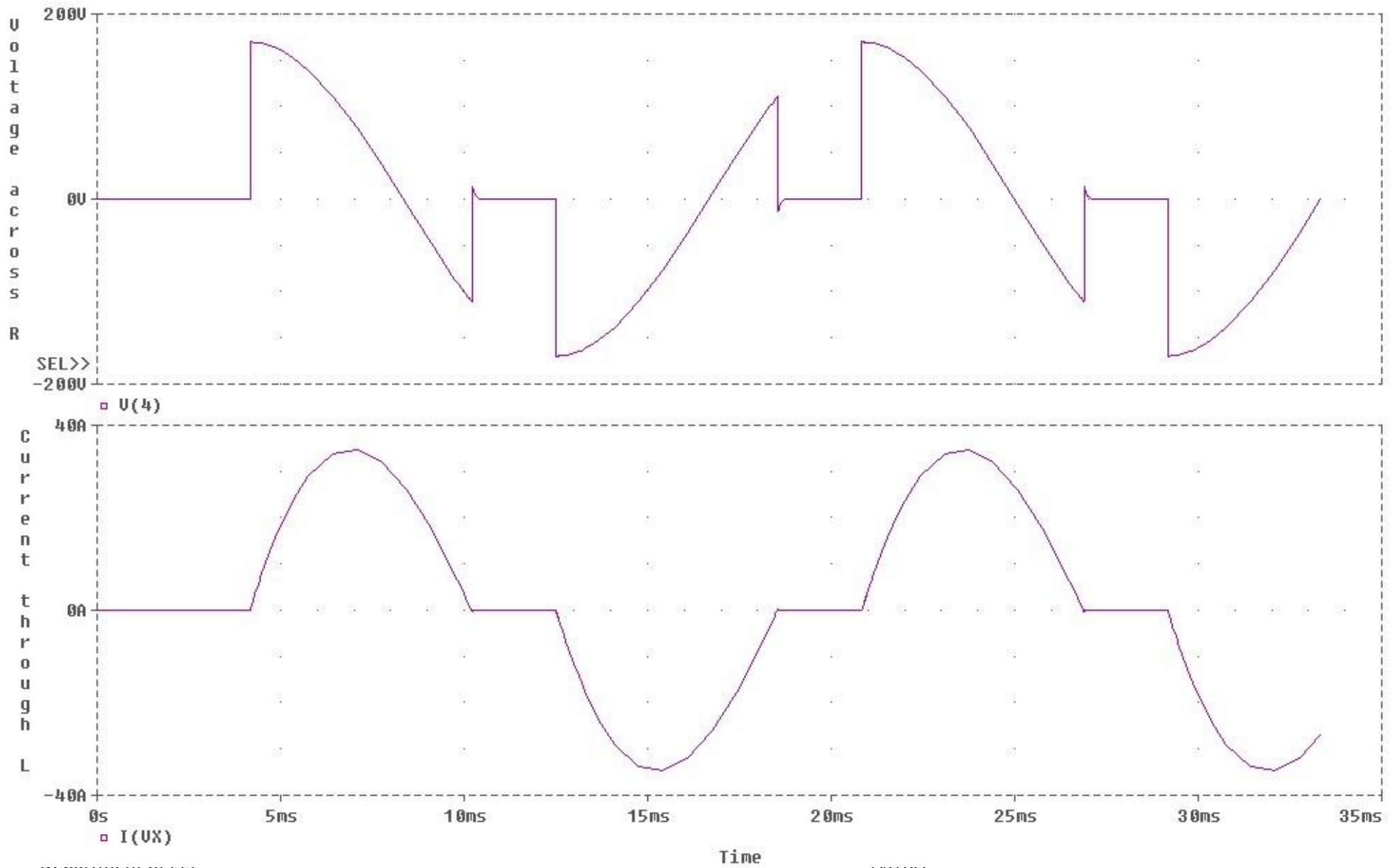
Result:

CIRCUIT DIAGRAM:

Cs 0.1UF

Rs 750 Ω

T1

1   2

4

T2

3

R   2.5 Ω

5

L   6.5mH

6

Vx 0V

Vs

2   3

OV VG1   OV VG2

4   1

SUB CIRCUIT:

Gate 3

la

Anode

S₁

RG   50Ω

5

4

0V Vx

0V Wy

Cathode

2

CT   1.0uF

RT   1Ω

F₁

6

Output Waveforms:

6.2. RESONANT PULSE COMMUTATION CIRCUIT

EXP NO:
Date:

Aim: To simulation Resonant Pulse Commutation Circuit by PSPICE.

Software Required: PSPICE (Personal Computer Simulated Program with
Integrated Circuit Emphasis.

Program:

VS 1 0 DC 200V

VG1 7 0 PULSE(0V 100V 0 1U 1U 0.4MS 1MS)

VG2 8 0 PULSE(0V 100V 0.4MS 1U 1U 0.6MS 1MS)

VG3 9 0 PULSE(0V 100V 0 1U 1U 0.2MS 1MS)

RG1 7 0 10MEG

RG2 8 0 10MEG

RG3 9 0 10MEG

C 1 2 31.2UF IC=200V

L 2 3 6.4UH

D1 4 1 DMOD

DM 0 4 DMOD

.MODEL DMOD D(IS=1E-25 BV=1800V TT=0)

RM 4 5 0.5

LM 5 6 5MH

VX 6 0 DC 0V

VY 1 10 DC 0V

.SUBCKT DCSCR 1 2 3 4

DT 5 2 DMOD

ST 1 5 3 4 SMOD

.MODEL DMOD D(IS=1E-25 BV=1800V TT=0V)

.MODEL SMOD VSWITCH(RON=0.1 ROFF=10E+6 VON=10V VOFF=5V)

.ENDS DCSCR

XT1 10 4 7 0 DCSCR

XT2 3 4 8 0 DCSCR

XT3 1 3 9 0 DCSCR

.TRAN 0.5US 3MS 1.5MS 0.5US

.PROBE

.END

O/p Waveform Details: I(VX) --- Current Through Load Terminals .

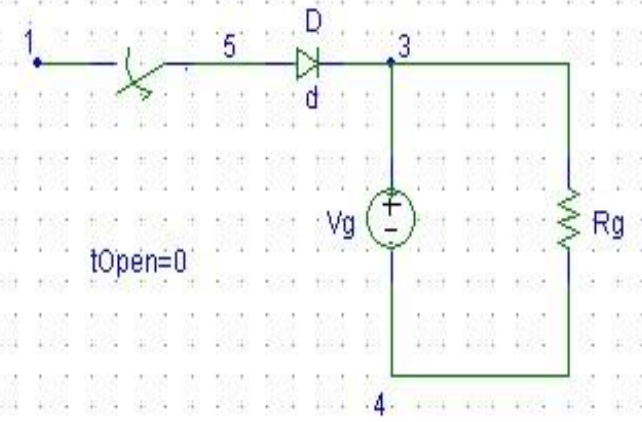I(C) ------ Current Through Capacitor.

V(1,2) --- Voltage Across the Capacitor.

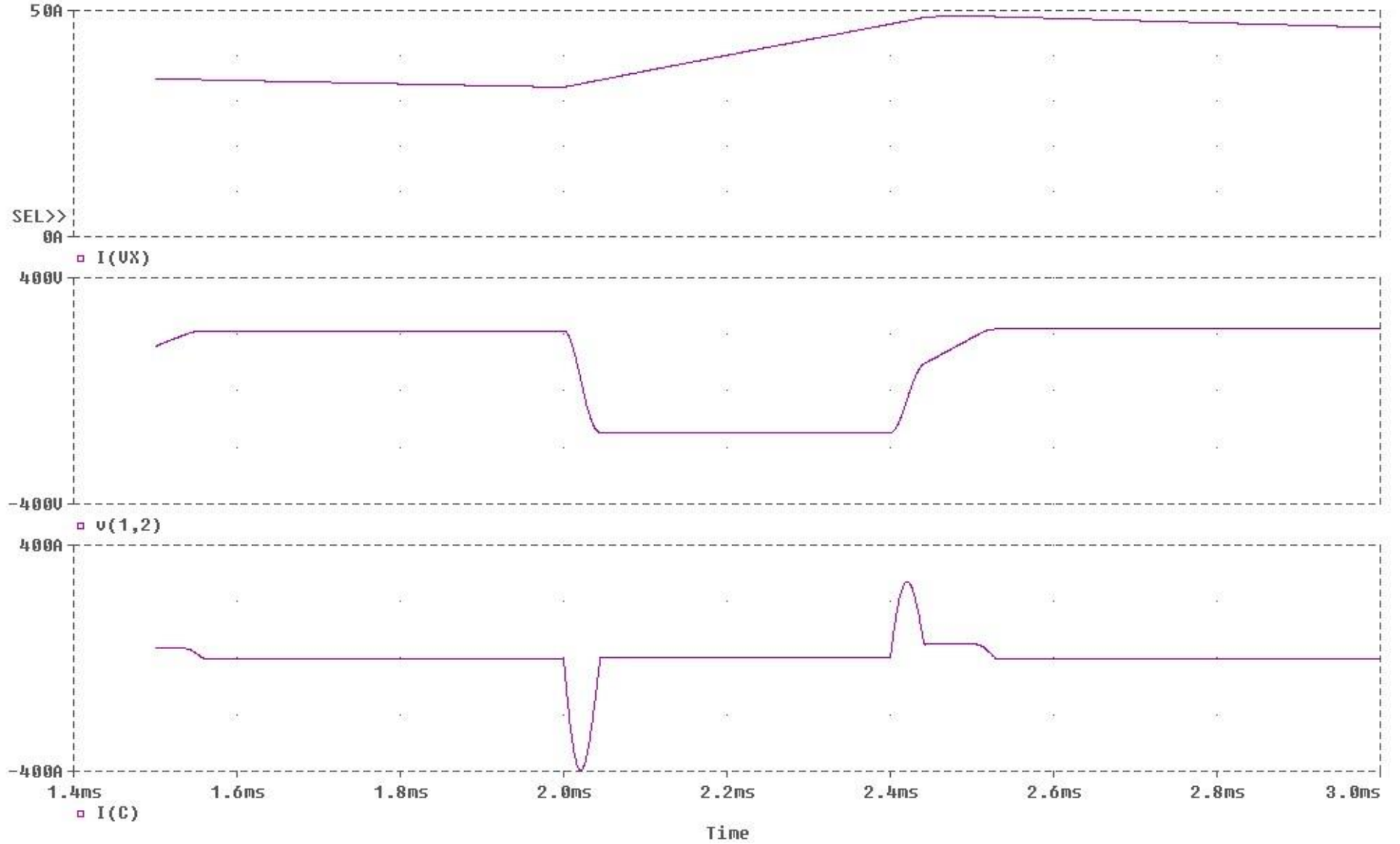**Result:** Analysis of Resonant Pulse Commutation has been successfully completed.

CIRCUIT DIAGRAM:

SUB CIRCUIT:

Power Electronic Simulation Lab
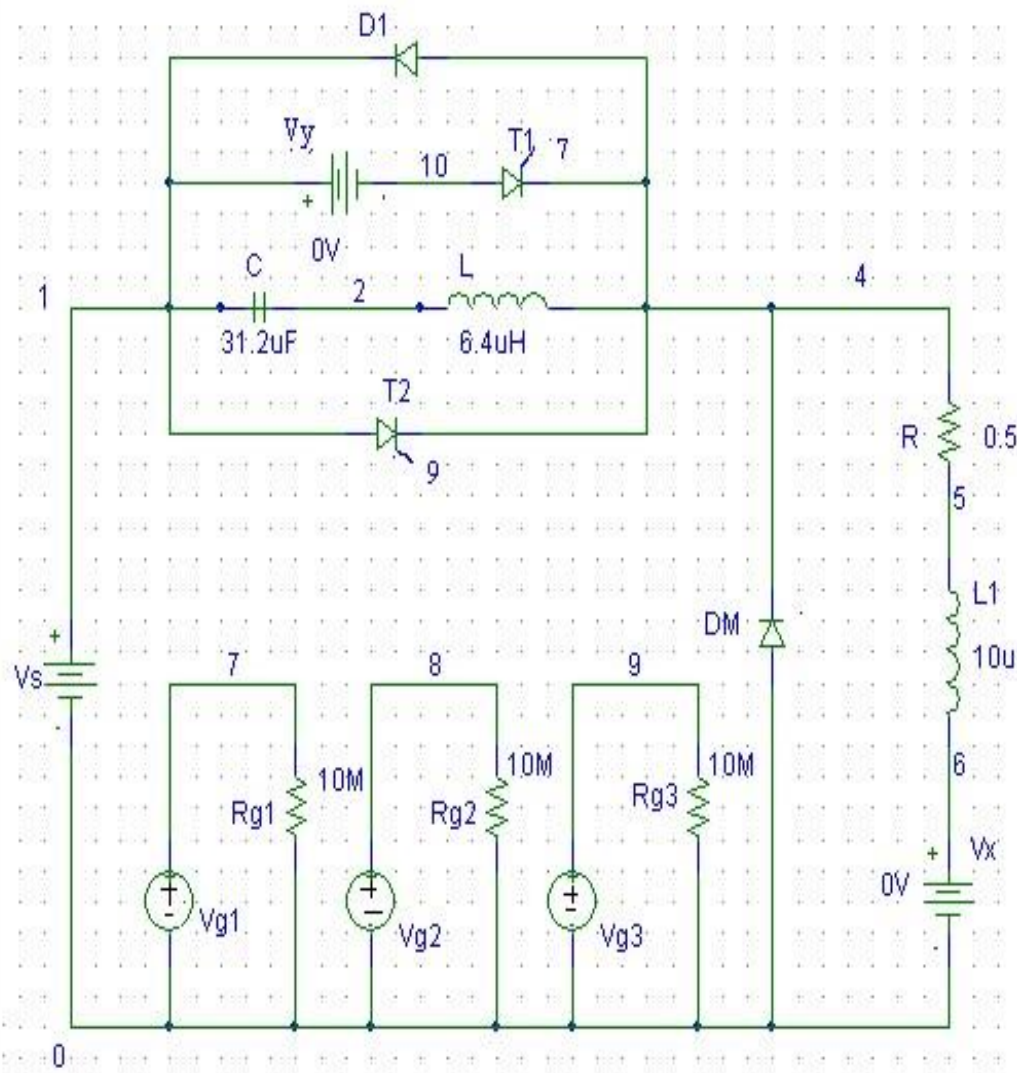
Output Waveforms:

6.3 THREE PHASE FULL CONVERTER USING RL & E LOADS

EXP NO:
Date:

Aim: To analyze the simulation of three phase full controlled converter with RL & E load.

Software Required: PSPICE (Personal Computer Simulated Program with Integrated Circuit Emphasis.

Program:

VAN 14 0 SIN(0V 200V 50HZ 0 0 0)

VBN 2 0 SIN(0V 200V 50HZ 0 0 -120)

VCN 3 0 SIN(0V 200V 50HZ 0 0 -240)

VG1 8 4 PULSE(0V 10V 5MS 1NS 1NS 100US 20MS)

VG2 11 3 PULSE(0V 10V 8.33MS 1NS 1NS 100US 20MS)

VG3 9 4 PULSE(0V 10V 11.66MS 1NS 1NS 100US 20MS)

VG4 13 1 PULSE(0V 10V 15MS 1NS 1NS 100US 20MS)

VG5 10 4 PULSE(0V 10V 18.33MS 1NS 1NS 100US 20MS)

VG6 12 2 PULSE(0V 10V 21.66MS 1NS 1NS 100US 20MS)

R 4 6 20

L 6 7 5.5MH

VX 7 5 DC 0V

VY 14 1 DC 0V

XT1 1 4 8 4 SCR

XT2 5 3 11 3 SCR

XT3 2 4 9 4 SCR

XT4 5 1 13 1 SCR

XT5 3 4 10 4 SCR

XT6 5 2 12 2 SCR

.SUBCKT SCR 1 2 3 2

S1 1 5 6 2 SMOD RG

3 4 50

DT 7 2 DMOD

VY 5 7 DC 0V

VX 4 2 DC 0V

RT 6 2 1

CT 6 2 10UF

FT 2 6 POLY(2) VX VY 0 50 11

.MODEL SMOD VSWITCH(RON=0.0125 ROFF=10E+5 VON=0.8V VOFF=0V)

.MODEL DMOD D(IS=2.2E-15 BV=1800V TT=0)

.ENDS SCR

.TRAN 5US 50MS 21.66MS

.PROBE

.END

O/p Waveform Details:

V(4,5) ------ Voltage across the load terminals.

I(Vx) ------- Current through the load.

V(14,0)------ Voltage across the Van to Neutral.

V(2,0) ------ Voltage across the Vbn to Neutral.

V(3,0) ------ Voltage across the Vcn to Neutral.

V(1,8) ------ Voltage across the T_1.

V(2,9) ------ Voltage across the T_2.

V(3,10) ------ Voltage across the T_3.

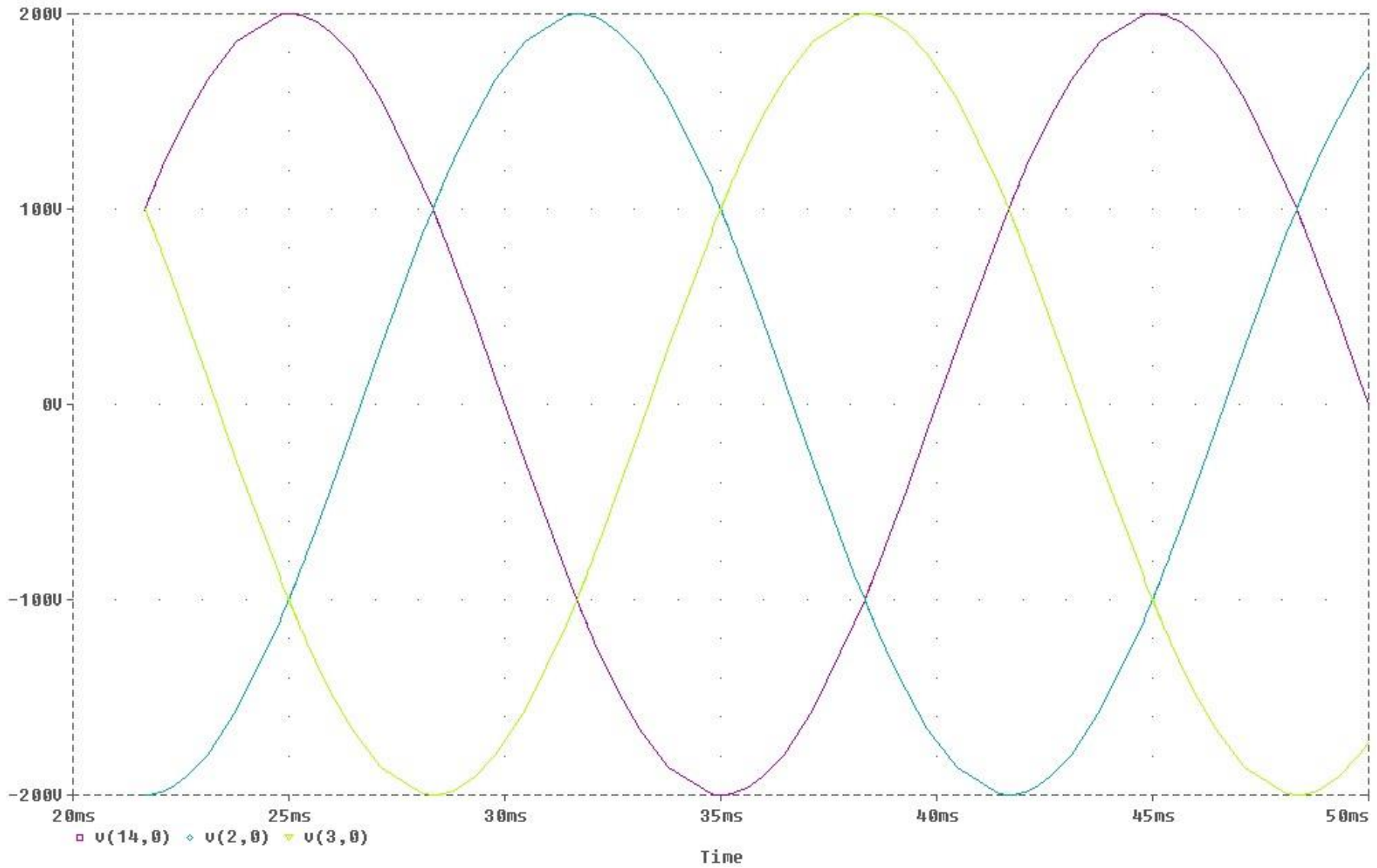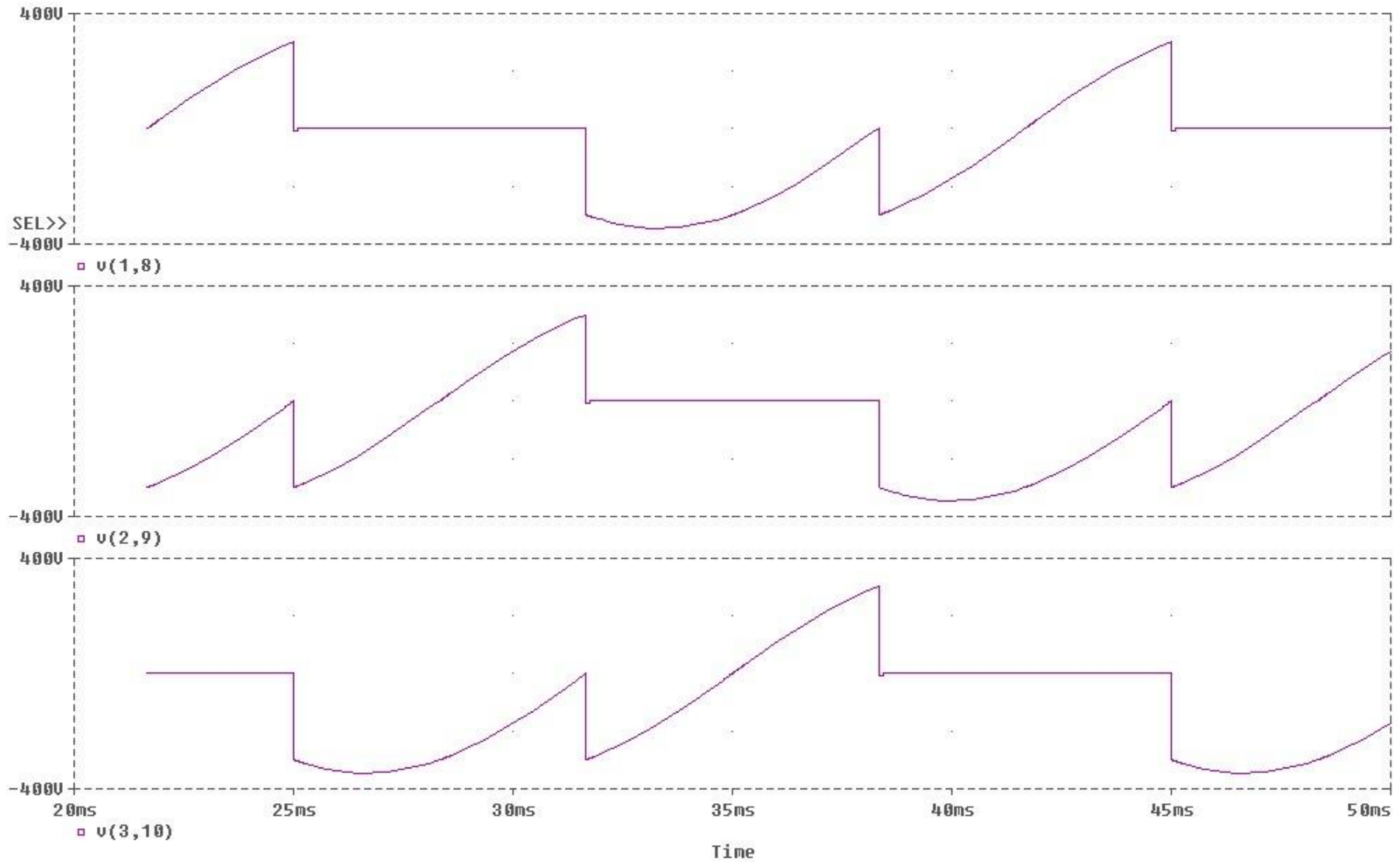**Result:** Analysis of three phase full controlled converter circuit has been Successfully completed.

CIRCUIT DIAGRAM:

SUB CIRCUIT:
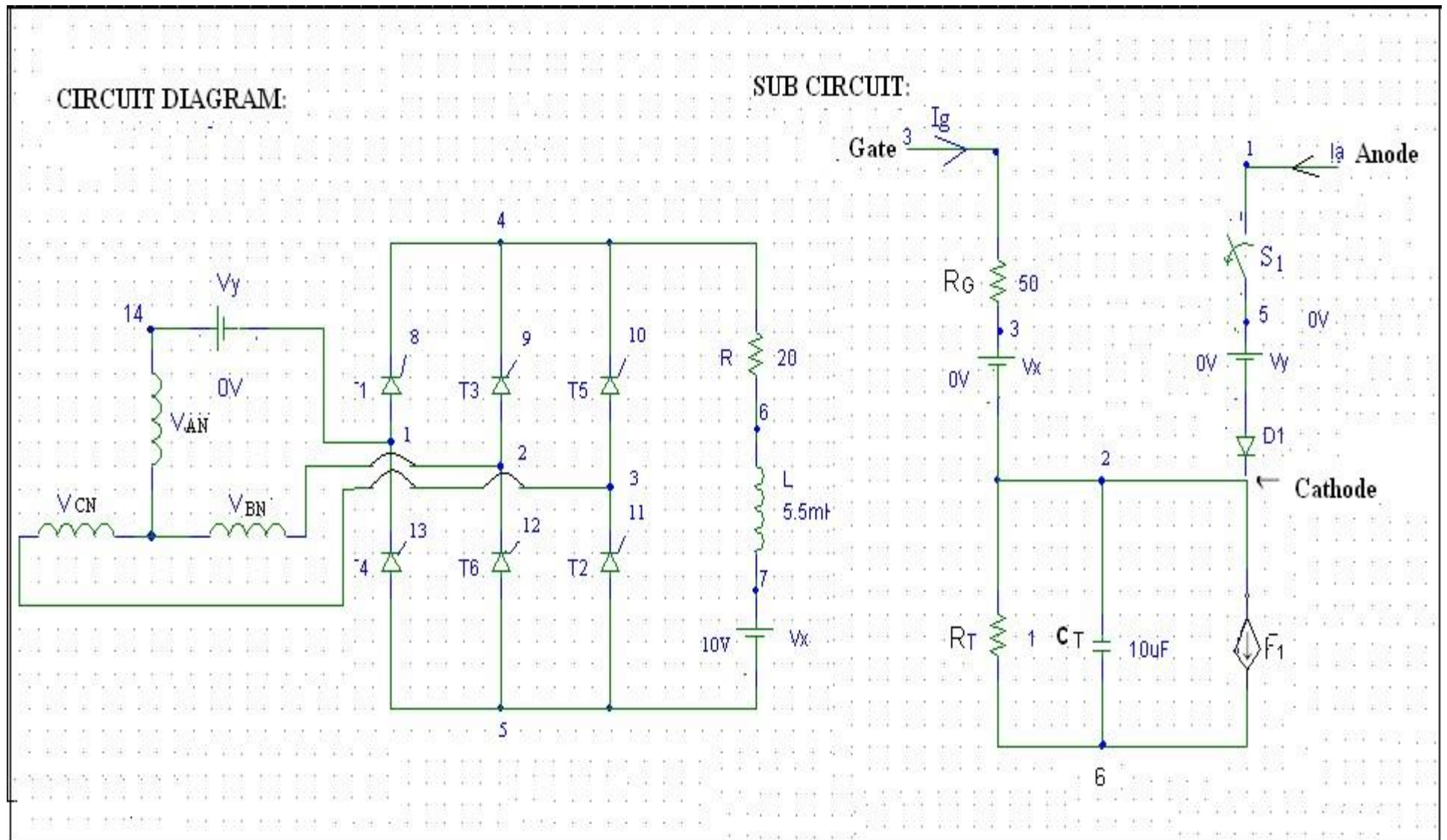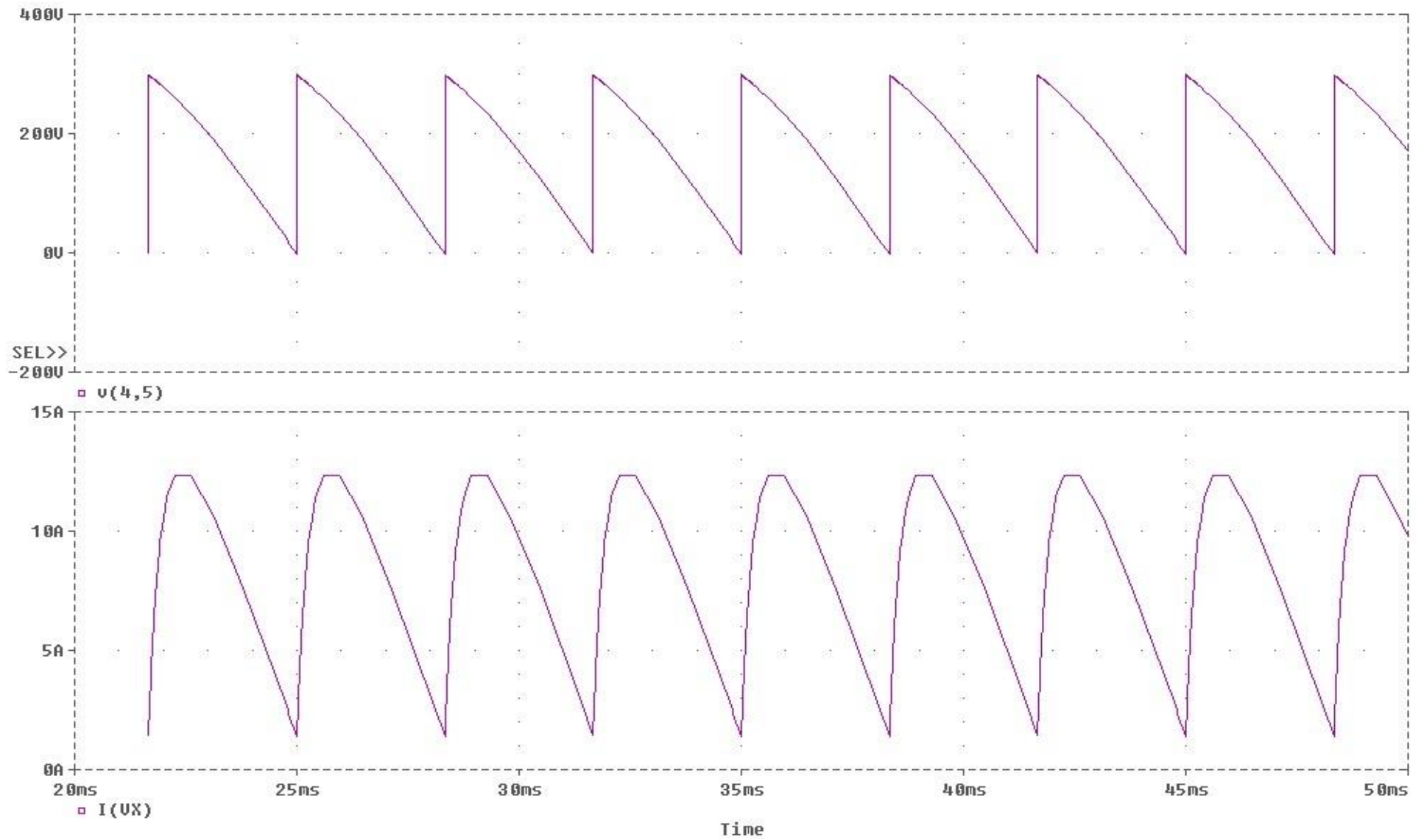
Output Waveforms:

Output Waveforms:

Output Waveforms:

Output Waveforms:

6.4 IMPULSE COMMUTATION CIRCUIT

EXP NO:

Date:

Aim: To simulation Impulse Commutation Circuit by using PSPICE.

Software Required: PSPICE (Personal Computer Simulated Program with Integrated Circuit Emphasis.

Program:

VS 1 0 DC 200V

VG1 5 0 PULSE(0V 100V 0 1US 0 0.4MS 1MS)

VG2 6 0 PULSE(0V 100V 0.4S 1US 1US 0.6MS 1MS)

VG3 7 0 PULSE(0V 100V 0 1US 1US 0.2MS 1MS)

RG1 5 0 10MEG

RG2 6 0 10MEG

RG3 7 0 10MEG

C 12 9 20UF IC=200V

LR 1 10 5UH

L1 1 13 25UH

D1 2 13 DMOD

DM 2 0 DMOD

.MODEL DMOD D(IS=1E-25 BV=1000V TT=0)

RM 2 3 10

LM 3 4 20MH

VX 4 0 DC 0V

VY 1 8 DC 0V

VZ 10 11 DC 0V

VA 8 12 DC 0V

XT1 8 2 5 0 DCSCR

XT2 11 9 6 0 DCSCR

XT3 9 2 7 0 DCSCR

.SUBCKT DCSCR 1 2 3 4

DT 5 2 DMOD

ST 1 5 3 2 SMOD

.MODEL DMOD D(IS=1E-25 BV=1000V TT=0V)

.MODEL SMOD VSWITCH(RON=0.1 ROFF=10E+6 VON=10V VOFF=5V)

.ENDS DCSCR

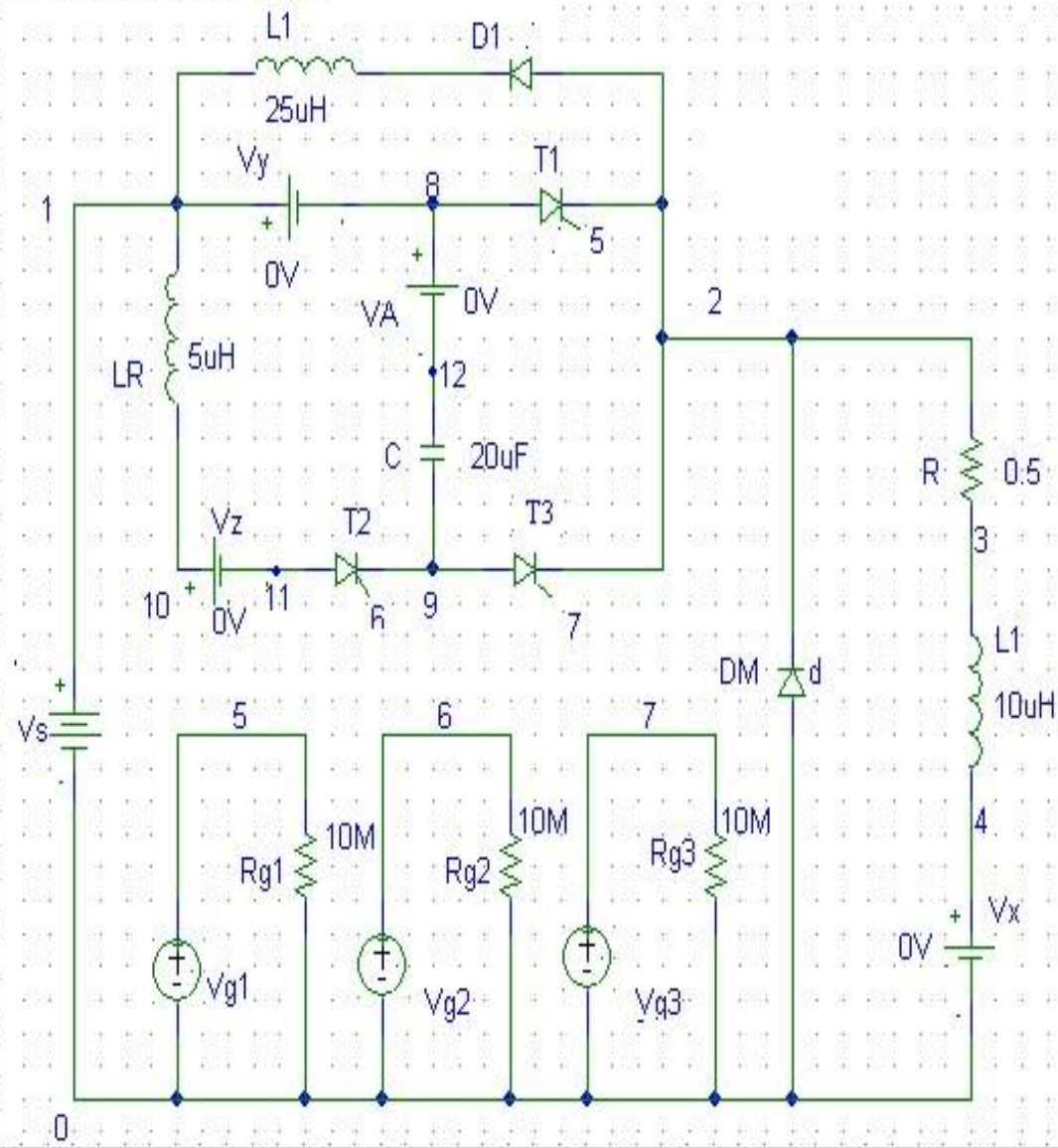.TRAN 0.5US 3MS 1.5MS 0.5US

.PROBE

.END

o/p Waveform Details: I(VX) --- Current Through Load Terminals **.**
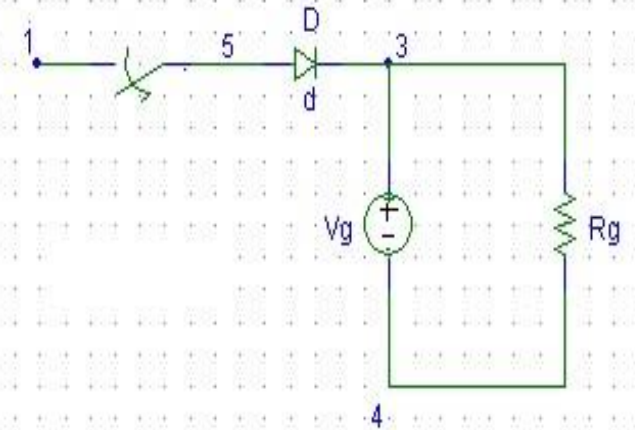
V(2,0) --- Voltage Across the diode.

Result: Analysis of Impulse commutation circuit has been successfully completed.
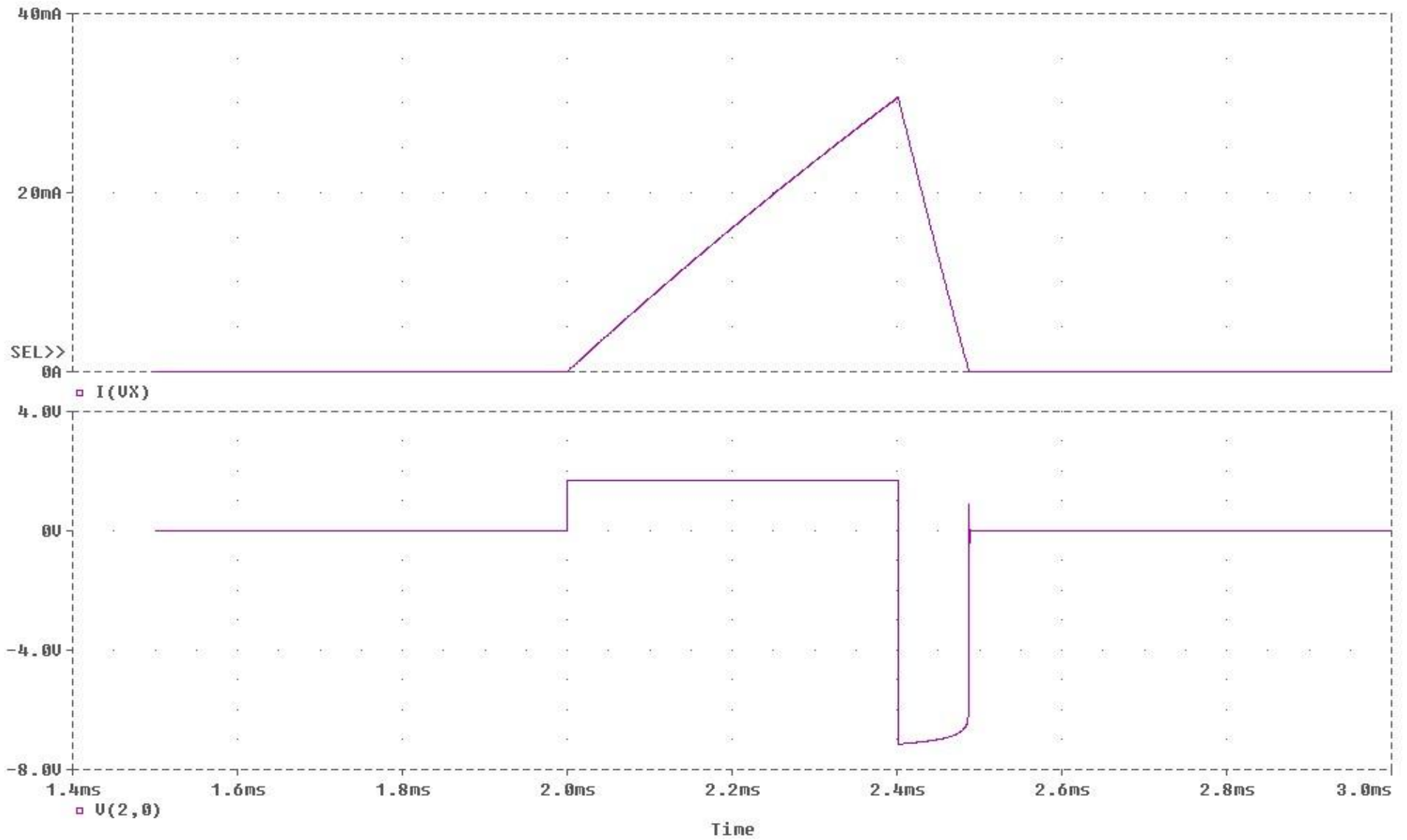
CIRCUIT DIAGRAM:

SUB CIRCUIT:

Output Waveforms:

6.5 THREE PHASE INVERTER WITH PWM CONTROLLER

EXP NO:
Date:

Aim: To simulation three phase Inverter with PWM controller circuit by using PSPICE.

Software Required: PSPICE (Personal Computer Simulated Program with

Integrated Circuit Emphasis.

Program:

VS 1 0 DC 100V

RB1 22 6 50

VG1 22 3 PULSE(0 40V 0 1NS 1NS 0.5MS 1MS)

RB2 16 15 50

VG2 16 0 PULSE(0 40V 166.67US 1NS 1NS 0.5MS 1MS)

RB3 8 7 50

VG3 8 4 PULSE(0 40V 333.33US 1NS 1NS 0.5MS 1MS)

RB4 12 11 50

VG4 12 0 PULSE(0 40V 550US 1NS 1NS 0.5MS 1MS)

RB5 10 9 50

VG5 10 5 PULSE(0 40V 666.67US 1NS 1NS 0.5MS 1MS)

RB6 14 13 50

VG6 14 0 PULSE(0 40V 833.33US 1NS 1NS 0.5MS 1MS)

VY 1 2 DC 0V

VX 3 20 DC 0V

RA 20 17 10

LA 17 21 5MH

RB 4 18 10

LB 18 21 5MH

RC 5 19 10

LC 19 21 5MH

D1 3 2 DMOD

D3 4 2 DMOD

D5 5 2 DMOD

D2 0 5 DMOD

D4 0 3 DMOD

D6 0 4 DMOD

.MODEL DMOD D(IS=2.2E-15 BV=1200V TT=0)

Q1 2 6 3 3 2N6546

Q3 2 7 4 4 2N6546

Q5 2 9 5 5 2N6546

Q2 5 15 0 0 2N6546

Q4 3 11 0 0 2N6546

Q6 4 13 0 0 2N6546

.MODEL 2N6546 NPN(IS=2.33E-27 BF=13 CJE=1PF CJC=607.3PF TF=26.5NS)

.TRAN 5US 2.5MS 1.0MS

.PROBE

.OPTIONS ABSTOL=1.0U RELTOL=1.0M VNTOL=1 ITL5=20000
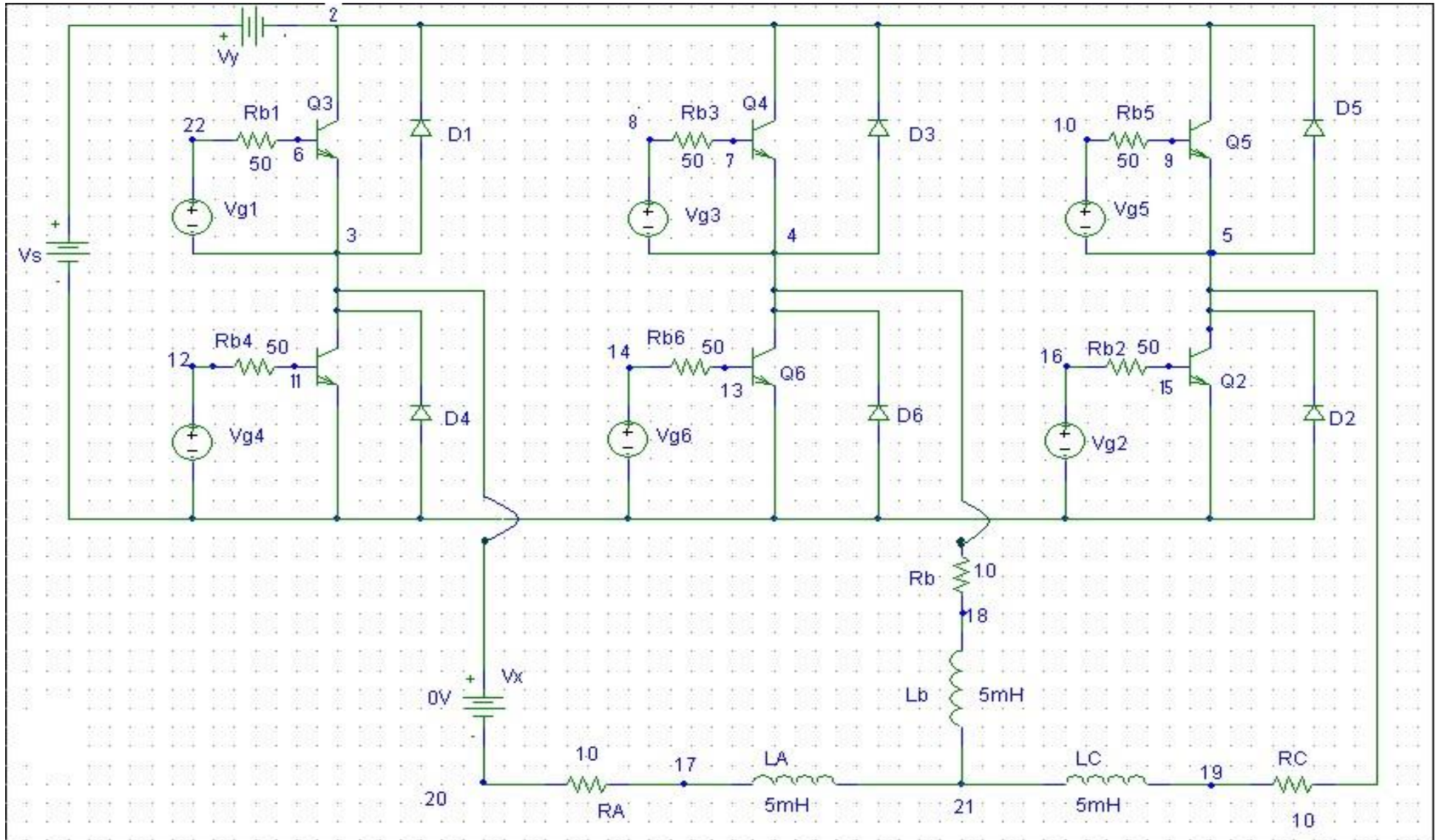
.FOUR 1KHZ I(VX) V(3,21)

.END

O/p Waveform Details: V(5,3) – Voltage across the R,B phases.
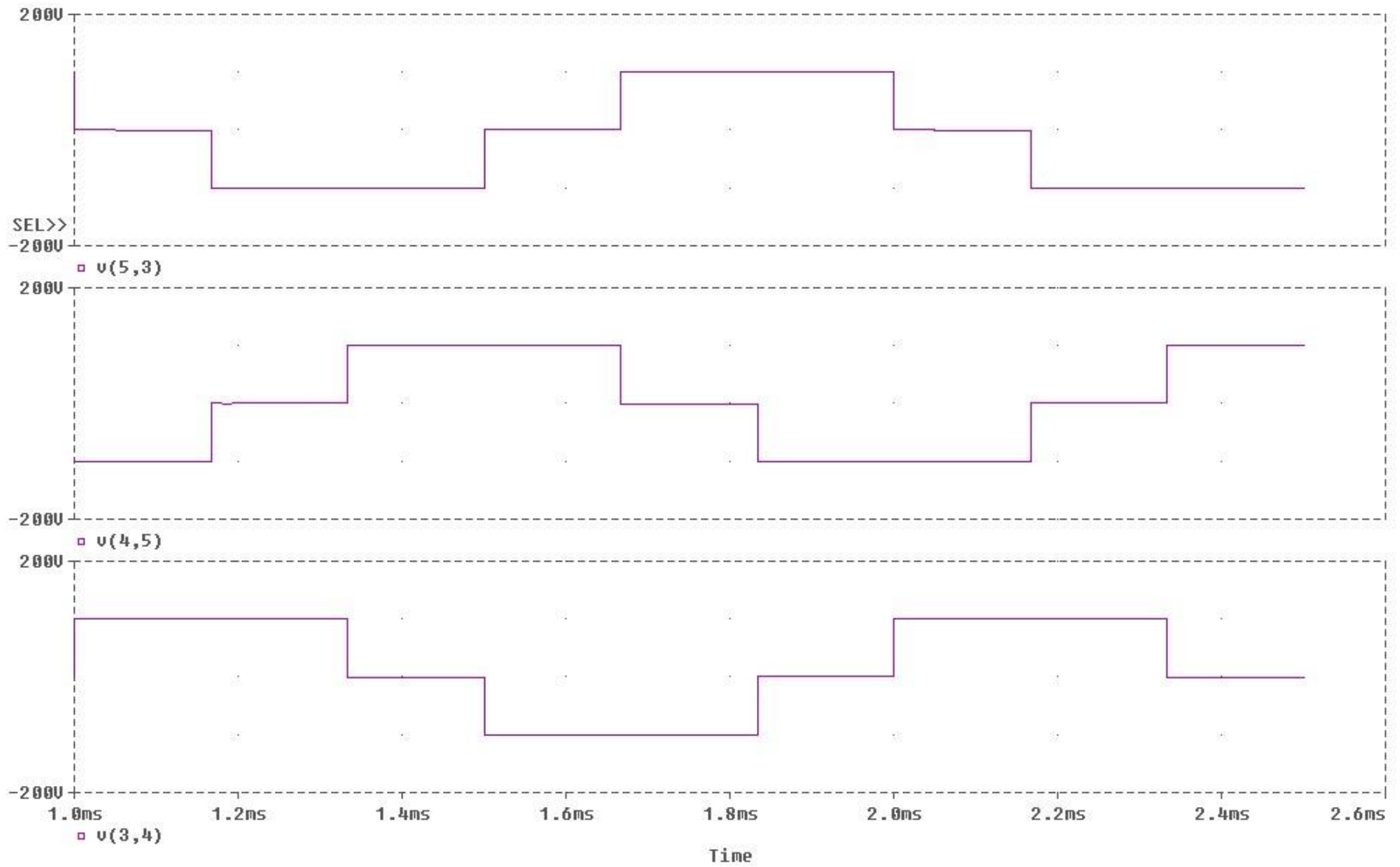
V(4,5) – Voltage across the Y,B phases.

V(3,4) – Voltage across the R,Y phases.

Result: Analysis of three phase inverter with PWM controller circuit has been Successfully completed.

CIRCUIT DIAGRAM:

Output Waveforms:

6.6 SINGLE PHASE FULL CONVERTER USING RL & E LOADS

EXP NO:

Date:

Aim: To analyze the simulation of 1Ø full controlled converter with RL & E load.

Software Required: PSPICE (Personal Computer Simulated Program with Integrated Circuit Emphasis.

Program:

VS 10 0 SIN(0 169.7V 60HZ)

VG1 6 2 PULSE(0V 10V 2777.78US 1NS 1NS 100US 16666.7US)

VG2 7 0 PULSE(0V 10V 2777.78US 1NS 1NS 100US 16666.7US)

VG3 8 0 PULSE(0V 10V 11111.1US 1NS 1NS 100US 16666.7US)

VG4 9 1 PULSE(0V 10V 11111.1US 1NS 1NS 100US 16666.7US)

*DF 3 2 DMOD

R1 2 4 10

L1 4 5 20MH

C1 2 11 793UF

RX 11 3 0.1

VX 5 3 DC 10V

VY 10 1 DC 0V

XT1 1 2 6 2 SCR

XT2 3 0 7 0 SCR

XT3 0 2 8 2 SCR

XT4 3 1 9 1 SCR

.SUBCKT SCR 1 2 3 2

S1 1 5 6 2 SMOD

RG 3 4 50

VX 4 2 DC 0V

VY 5 7 DC 0V DT

7 2 DMOD

RT 2 6 1

CT 6 2 10UF

F1 2 6 POLY(2) VX VY 0 50 11

.MODEL SMOD VSWITCH(RON=0.0125 ROFF=10E+5 VON=5V VOFF=0V)

.MODEL DMOD D(IS=2.2E-15 BV=1800 TT=0)

.ENDS SCR

.TRAN 10US 100MS 16.6MS

.PROBE

.FOUR 120HZ I(VX)

.END

O/p Waveform Details: V(2,3) – Voltage across the load terminals.

I(Vx) – current across the load terminals.

Result: Analysis of 1Ø full controlled converter circuit has been successfully completed.
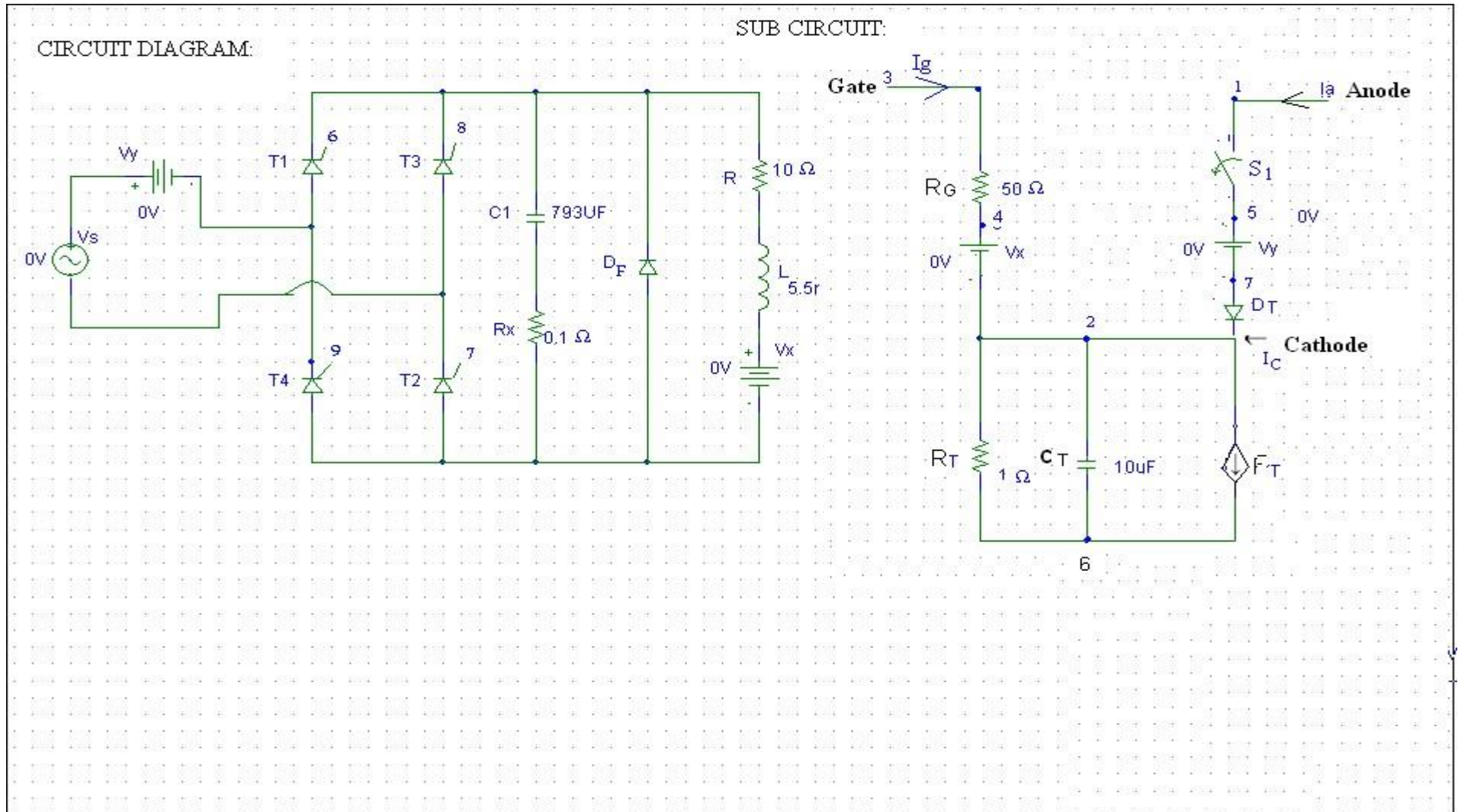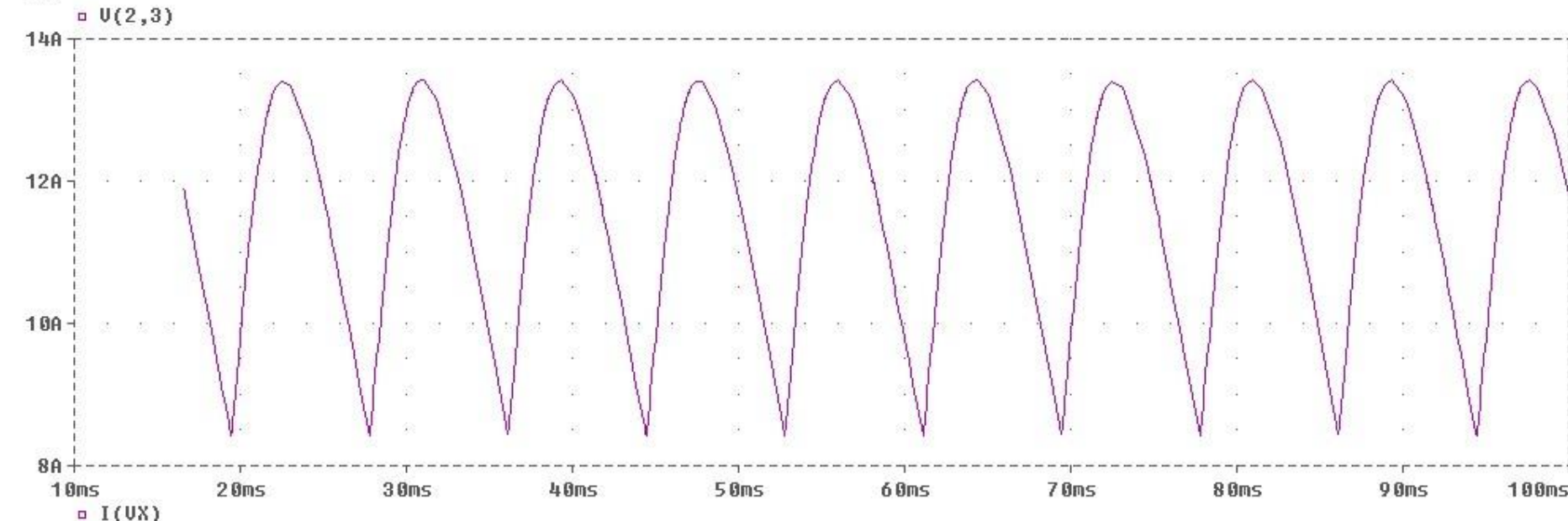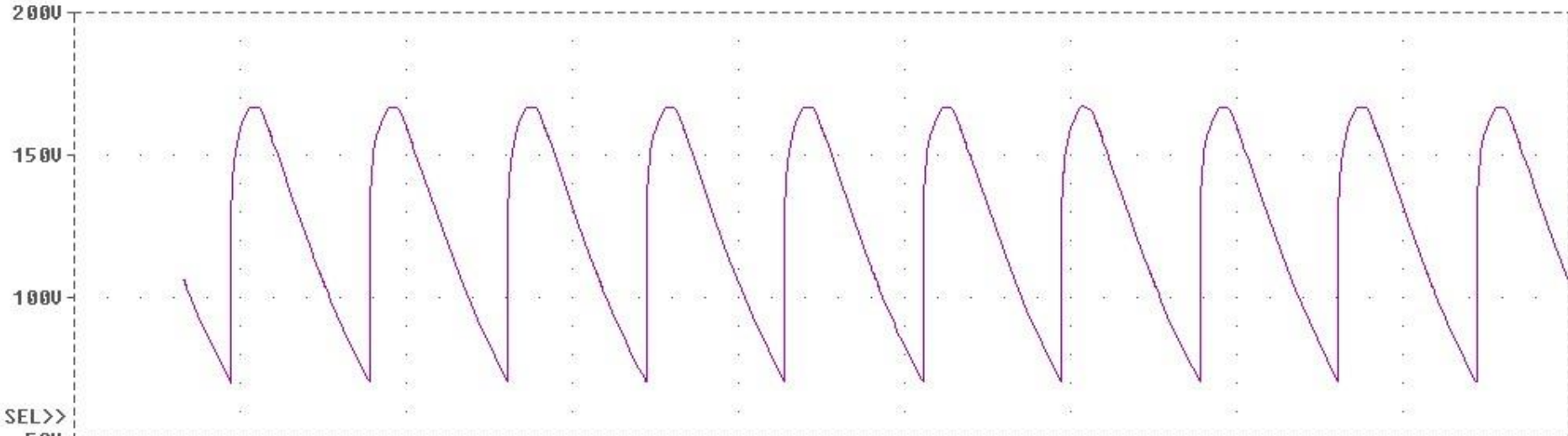
CIRCUIT DIAGRAM:

SUB CIRCUIT:

OUTPUT

WAVEFORMS:

6.7 THREE PHASE HALF CONTROLLED BRIDGE CONVERTER

EXP NO:

Date:

Aim: To study the three phase half controlled bridge converter with R & RL Load.

Apparatus required:

Personal Computer With PSIM

CIRCUIT DIAGRAM:

PROCEDURE:

MODULE CALCULATIONS:

V_0 = (3√2V /2∏) * (1+Cos□)

I_0 = (3√2V /2∏R) * (1+Cos □)

□ = Firing Angle

V = RMS Value across transformer output

MODEL GRAPH:

RESULT: The three phase half controlled bridge converter with R & RL Load is studied.

6.8 .SINGLE PHASE CYCLOCONVERTER

EXP NO:
Date:

AIM: To study the single phase Cyclo converter with R & RL Load.

Apparatus required:

Personal Computer With PSIM

CIRCUIT DIAGRAM:

PROCEDURE:

MODULE CALCULATIONS:

V_{0r} = (V / √π) * [(π-□□□□□□□sin2□□□□□□□□
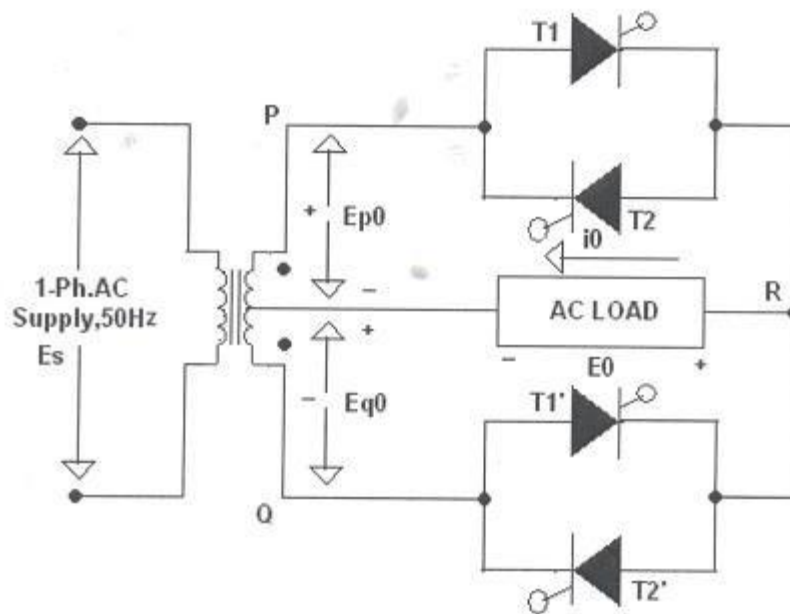
I_{0r} = V_{0r} / R

☐   = Firing Angle

V   = RMS Value across transformer output

MODEL GRAPH:
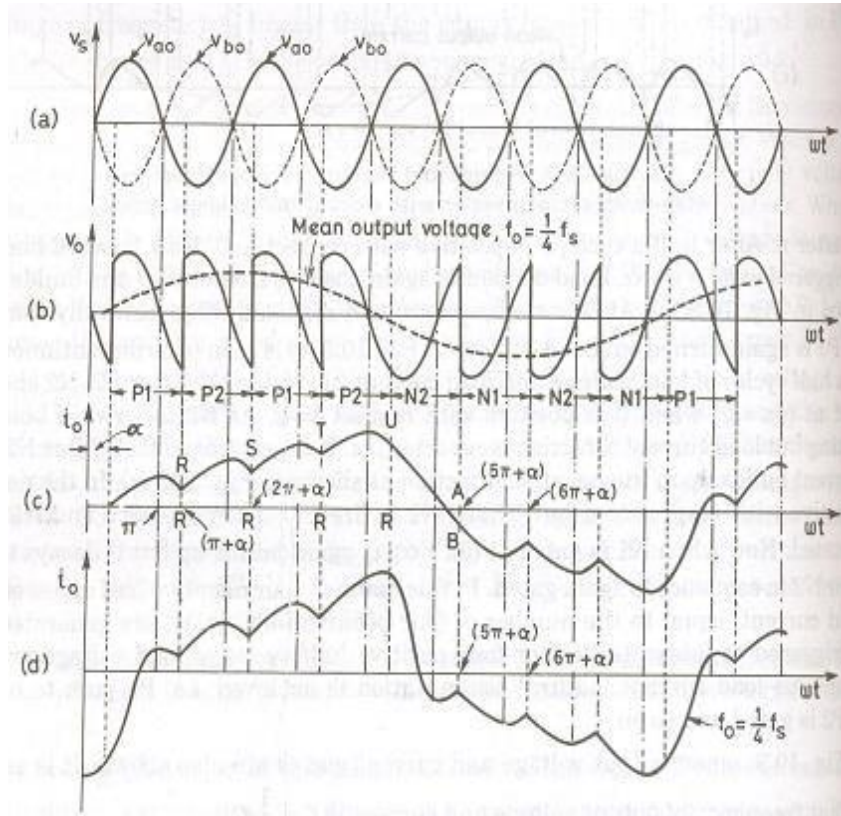
RESULT: The single phase Cyclo converter with R & RL Load is studied.

6.9.SINGLE PHASE HALF CONTROLLED BRIDGE CONVERTER
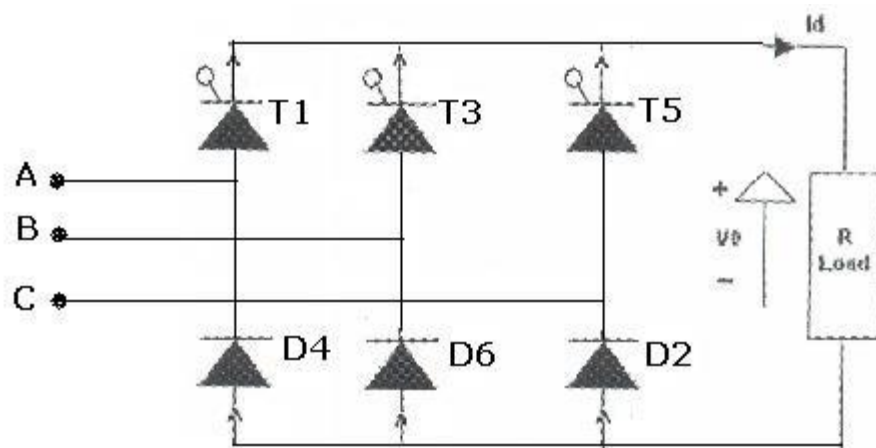
EXP NO:

Date:

Aim: To study the single phase half controlled bridge converter with R & RL Load.

Apparatus required:

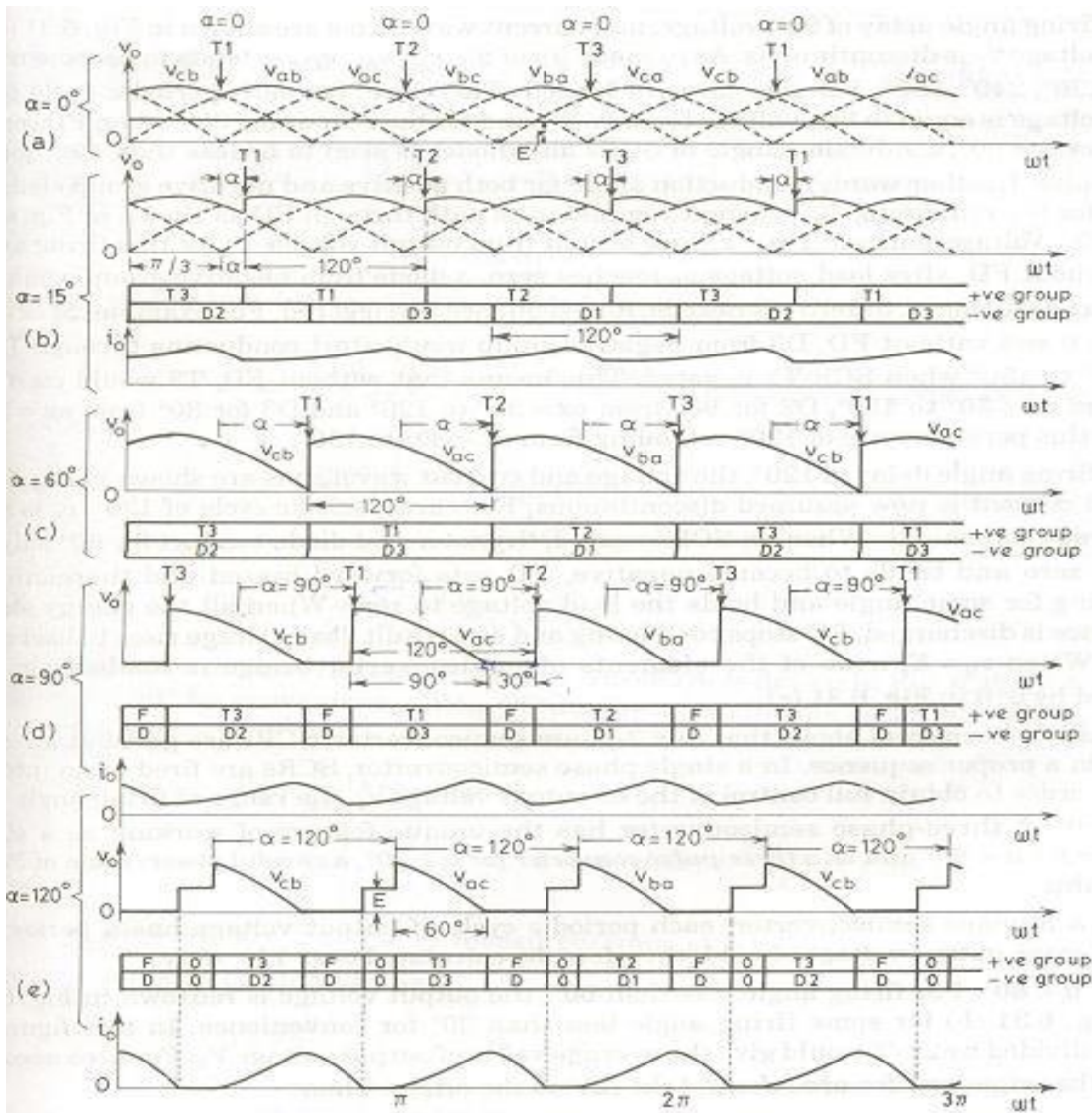Personal Computer With PSIM

CIRCUIT DIAGRAM:

ISOLATION TRANSFORMER

PROCEDURE:

MODULE CALCULATIONS:

$V_0 \quad = (\sqrt{2}V / \pi) * (1+\cos\alpha)$

$I_0 \quad = (\sqrt{2}V / \pi R) * (1+\cos\alpha)$

$\alpha \quad = \text{Firing Angle}$

$V \quad = \text{RMS Value across transformer output}$

MODEL GRAPH:
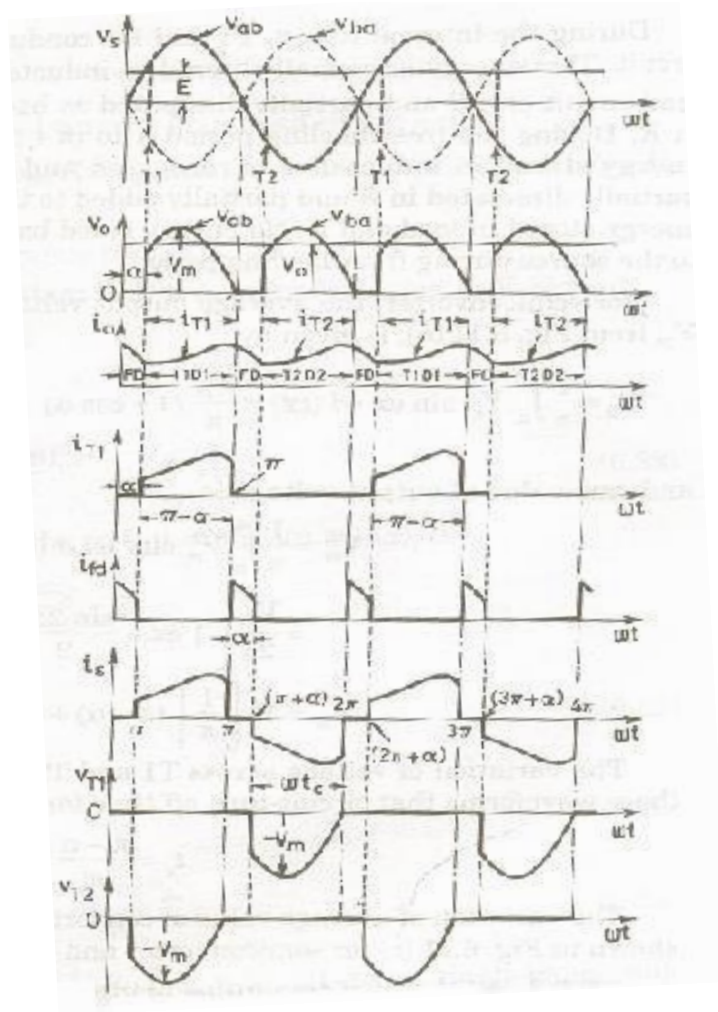
RESULT: Hence the single phase half controlled bridge converter with R-Load has been studied and respective graphs have been plotted after the readings being tabulated.

6.10. SINGLE PHASE FULLY CONTROLLED BRIDGE CONVERTER

EXP NO:

Date:

Aim: To study the single phase fully controlled bridge converter with R & RL Load.

Apparatus required:
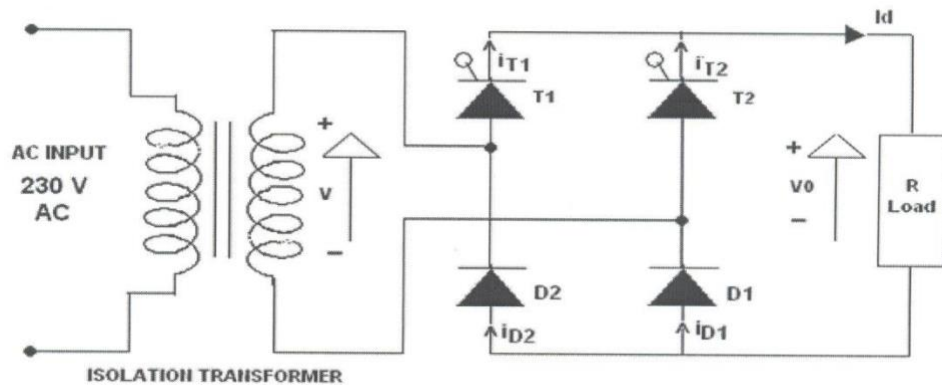
Personal Computer With PSIM

CIRCUIT DIAGRAM:

ISOLATION TRANSFORMER
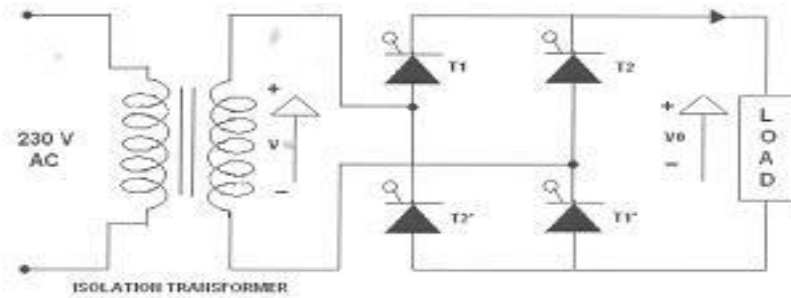
PROCEDURE:

MODULE CALCULATIONS:

For R-L Load: **For R Load:**

V_0 = $(2\sqrt{2}V/\Pi)$ * Cos α $V_0 = (\sqrt{2}V/\Pi)$ * $(1+Cos\alpha)$

I_0 = $(2\sqrt{2}V/\Pi Z)$ * Cos α $I_0 = (\sqrt{2}V/\Pi R)$ * $(1+Cos\alpha)$

α = Firing Angle

V   = RMS Value across transformer output

MODEL GRAPH:
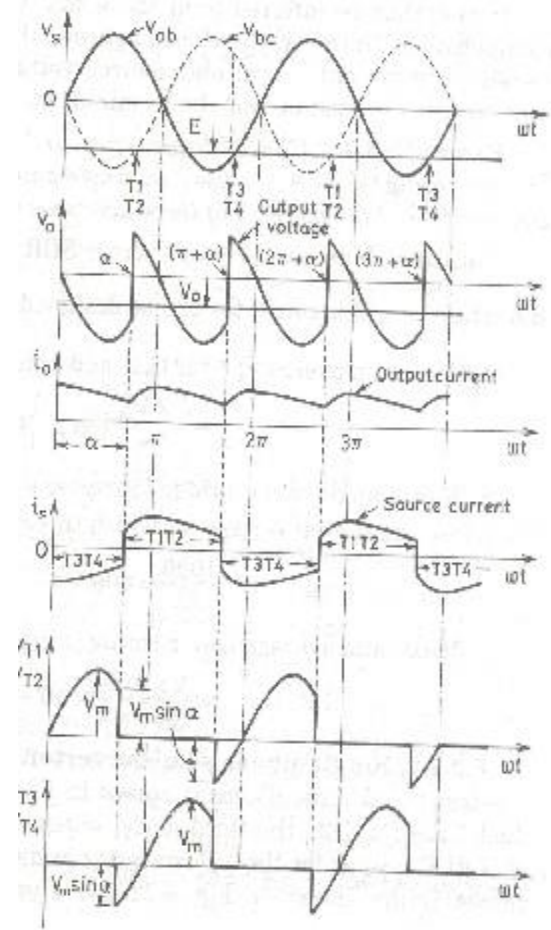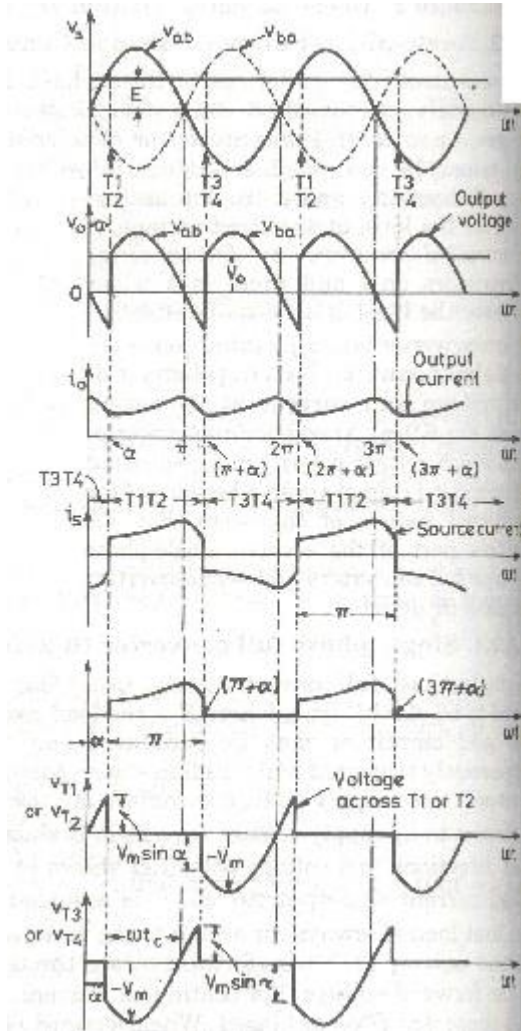
fig: out put wave forms for $\alpha > 90°$,

Fig: out put wave forms for $\alpha \square \square \square \square \square^{\square}$

RESULT: Hence single phase fully controlled bridge converter with R and R-L load has been studied and respective graphs have been plotted after the readings being tabulated.

7. Content beyond syllabus:

1. Three phase AC voltage controller

2. Three phase Cyclo converter.

3. Series inverter and Praller inverter

4. Jhones chopper

5. Four quadrent chopper

Sample Viva Voce Questions

Exp: 6.1.1

1) Explain V-I characteristics of SCR?
2) What are Latching current and Holding current?
3) Define V_{BO} & V_{BR}? Which has a grater value and why?
4) Why is Latching current greater than Holding current?
5) What is the effect of increasing gate current in the turning on of SCR

Exp: 6.2

1) Explain R,RC and UJT triggering? Which is the most effective?

2) What is the maximum possible firing angle in R-Triggering?

3) How the triggering pulses are generated in UJT triggering?

4) How to change the triggering instants in UJT triggering?

5) Explain the waveforms?

Exp: 6.3

1) Explain the working of AC Voltage controller?

2) Define Displacement angle, Displacement factor and distortion factor?

3) Displacement angle * Displacement factor = _____ 4) Explain the waveforms with R & RL load?

5) With RL load, the firing angle should be always greater than power factor. Why? (What is the effect of power factor in the working of an AC voltage controller with RL load?)

Exp: 6.4

1) What are the different configurations for a Fully Controlled converter?

2) Explain the working of a Fully Controlled converter?

3) Explain the waveforms with R & RL loads?

4) What is the equation for average voltage in a Fully Controlled converter?

5) What are the applications of a Fully Controlled converter?

Exp: 6.5

1) Explain the working of a Half controlled converter?

2) What are the disadvantages ?

3) Explain the waveforms with R & RL loads?

4) What is the equation for average voltage in a Half controlled converter?

5) What are the two different modes of operation in a Half controlled converter?

Exp: 6.7

1) What are the applications of cycloconverters?

2) How the frequency change is made possible in cycloconverters?

3) What are the different types of cycloconverters? Explain each?

4) Explain the sequence of triggering for $(1/3)^{rd}$ frequency?

5) Draw & Explain waveforms for RL load?

Exp: 6.8

1) Explain the working of a series inverter?

2) Explain the waveforms?

3) What are the applications?

4) What are the differences between a basic series inverter and a modified one?

Exp: 6.9

1) What is a chopper?

2) What are the different types of Choppers?

3) Explain the working?

4) Explain the waveforms?

Exp: 6.10

1 what is other name for class A commutation? 2
what is other name for class B commutation? 3
what is other name for class C commutation?
4 what is other name for class D commutation? 5
what is other name for class E commutation?

8.   Sample Question paper of the lab external

1   Simulate the Single phase ac voltage controller

2   Simulate the Resonant pulse commutation circuit

3   Simulate the Three phase full converter using rl&e loads

4   Simulate the Impulse commutation circuit

5   Simulate the Three phase inverter with pwm controller

6   Simulate the Single phase full converter

7   Simulate the Three phase half controlled bridge converter

8   Simulate the Single phase cycloconverter

9   Simulate the Single phase half controlled bridge converter

10   Simulate the Single phase fully controlled bridge converter

10.   Applications of the laboratory :

1   WIth the healp of this lab the student can able to learn the simulation of many power electronics converters

2   He or she can be able to do the analysis of different pwer electronics devices 3

Can able to learn the performance of many power devices

11. Precautions to be taken while conducting the lab

➢ Power must be switched-OFF while making any connections.

➢ Do not come in contact with live supply.

➢ Power should always be in switch-OFF condition, EXCEPT while you are taking readings.

➢ The Circuit diagram should be approved by the faculty before making connections.

➢ Circuit connections should be checked & approved by the faculty before switching on the power.

➢ Keep your Experimental Set-up neat and tidy.

➢ Check the polarities of meters and supplies while making connections.

➢ Always connect the voltmeter after making all other connections.

➢ Check the Fuse and it's ratify.

➢ Use right color and gauge of the fuse.

➢ All terminations should be firm and no exposed wire.

➢ Do not use joints for connection wire.

SAFETY – II

1. The voltage employed in electrical lab are sufficiently high to endanger human life.

2. Compulsorily wear shoes.

3. Don't use metal jewelers on hands.

4. Do not wear loose dress

Don't switch on main power unless the faculty gives the permission

12. Code of Conduct

1   Students should report to the labs concerned as per the timetable.

2.   Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.

3. After completion of the experiment, certification of the staff in-charge concerned in the observation book is necessary.

4. Students should bring a notebook of about 100 pages and should enter the readings/observations/results into the notebook while performing the experiment.

5. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate previous session should be submitted and certified by the staff member in-charge.

6. Not more than three students in a group are permitted to perform the experiment on a set up.

7. The group-wise division made in the beginning should be adhered to, and no mix up of student among different groups will be permitted later.

8. The components required pertaining to the experiment should be collected from Lab- in-charge after duly filling in the requisition form.

9. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.

10. Any damage of the equipment or burnout of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.

11. Students should be present in the labs for the total scheduled duration.

12. Students are expected to prepare thoroughly to perform the experiment before coming to Laboratory.

13. Procedure sheets/data sheets provided to the students' groups should be maintained neatly and are to be returned after the experiment.

13. Graphs if any.