15EE301J- POWER ELECTRONICS LAB

RECORD NOTEBOOK

SEMESTER V

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

SRM UNIVERSITY

KATTANKULATHUR-603203

15EE301J	**POWER ELECTRONICS LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact hours –30	**0**	**0**	**2**	**1**
	Prerequisite				
	NIL				
PURPOSE					
To learn the characteristics and applications of power electronic devices and circuits.					
INSTRUCTIONAL OBJECTIVES					
1.	To Learn the characteristics of different types of power electronic devices				
2.	To Understand and analyze the operation of controlled rectifiers , choppers, inverters				
3.	To Understand the operation of AC to AC converters and applications of power electronic circuits				

LIST OF EXPERIMENTS

Cycle 1

1. Single Phase Full Converter
2. Series Inverter
3. Single phase Cycloconverter
4. CUK Converter
5. Three Phase PWM inverter
6. Voltage Commutated Chopper

Cycle 2

7. Single Phase AC voltage controller using TRIAC
8. Parallel Inverter
9. SEPIC Converter
10. Cascaded multi-level Inverter
11. Simulation of Boost converter using MATLAB

INDEX

Sl. No.	Name of the experiment	Page no	Exp (40)	Viva (5)	Record (5)	Signature of the staff
1	Single-phase Full converter					
2	Series Inverter					
3	Single phase Cycloconverter					
4	CUK Converter					
5	Three Phase PWM inverter					
6	Voltage Commutated Chopper					
7	Single Phase AC voltage controller using TRIAC					
8	Parallel Inverter					
9	SEPIC converter					
10	Cascaded multi-level Inverter					
11	Simulation of Boost converter using MATLAB					
Total Marks						
Average						

Staff In-charge

EXPERIMENT NO. 1

SINGLE PHASE FULLY CONTROLLED CONVERTER

Name of the candidate	**:**	
Register Number	**:**	
Date of Experiment	**:**	

Sl.No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** a. Connection	10	
	b. Execution	10	
	c. Calculation	10	
	d. Evaluation	10	
	Total	**40**	
2	**Viva:-** a. Pre Lab (2.5)	5	
	b. Post Lab(2.5)		

Pre-Lab Questions

Single Phase Fully Controlled Converter

1. If firing angle is greater than 90 degrees, the converter circuit formed is called as?

2. What is displacement factor?

3. What is DC output voltage of single phase full wave controller?

Expt.No.1 Single Phase Full Converter

Aim

To study the performance of single phase fully controlled converter using R and RL load

Apparatus Required

1. Power Electronics Rectifier (Trainer) Kit
2. CRO
3. Connecting Wires

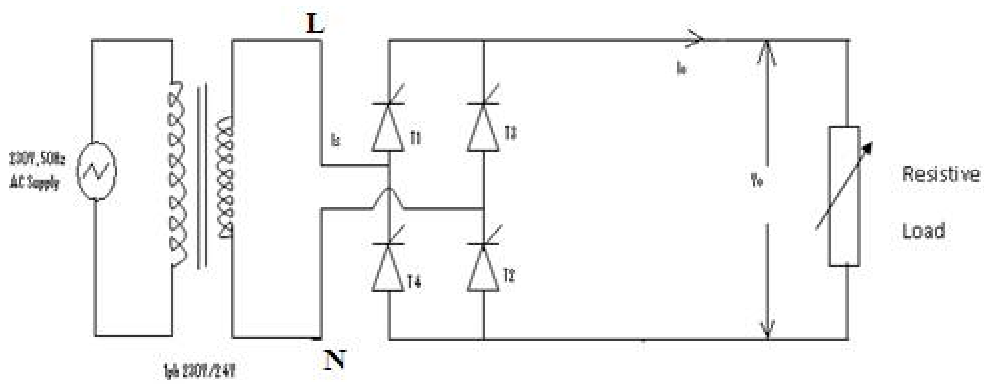

Fig 1 Single phase full converter

Theory

A fully controlled converter or full converter uses thyristors only and there is a wider control over the level of dc output voltage. With pure resistive load, it is a single quadrant converter. Here, both the output voltage and output current are positive. With RL- load it becomes a two-quadrant converter. Here, output voltage is either positive or negative but output current is always positive. Fig.1 shows a single phase fully controlled rectifier with resistive load. This type of full wave rectifier circuit consists of four SCRs. During positive half cycle, SCRs T1 and T2 are forward biased. At $\omega t = \alpha$, SCRs T1 and T2 are triggered, then the current flows through the L – T1- R load – T2 – N. At $\omega t = \pi$, supply voltage falls to zero and the current also goes to zero. Hence SCRs T1 and T2 turned off. During negative half cycle (π to 2π),SCRs T3 and T4 are forward biased. At $\omega t = \pi + \alpha$, SCRs T3 and T4 are triggered, then current flows through the path N – T3 – R load- T4 – L. At $\omega t = 2\pi$, supply voltage and current goes to zero, SCRs T2 and T4 are turned off. Fig 3 shows the current and voltage waveforms for this circuit.

$$V_{out} = \frac{2V_m}{\pi}(\cos\alpha)\,; \qquad I_{avg} = \frac{V_{avg}}{R}$$

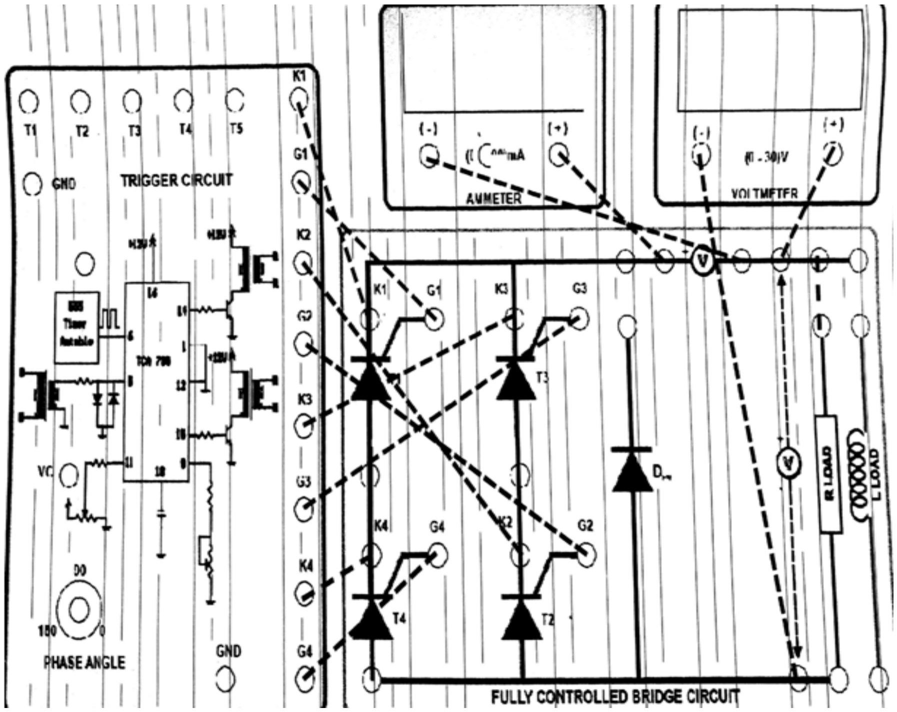

Fig 2 Patch connection details in a single phase Full converter

Procedure

1. Make the connections as per the circuit diagram. ie. Connect the SCRs gate trigger signal to cathode and gate terminal of SCRs as per connection
2. Connect CRO and multimeter (in dc) across the load.
3. Set the phase control pot at the maximum position (ie. Phase angle of 180^{o}).
4. Switch on the step down ac source.
5. Observe the voltage across the load using CRO and note the triggering angle ‘α’ and note the corresponding reading of the multimeter. Also note the value of maximum amplitude Vm from the waveform.
6. Vary the phase control by setting the pot at different positions and follow the step given in (5) for every position.
7. Tabulate the readings in observation column
8. Draw the observed waveforms.

Observation Table

For R Load

Serial No.	Triggering angle ‘α’ degree	Output voltage Vo (V) (measured)	Time period(ms)
1 2 3			

For RL Load

Serial No.	Triggering angle ‘α’ degree	Output voltage Vo (V) (measured)	Time period(ms)
1 2 3			

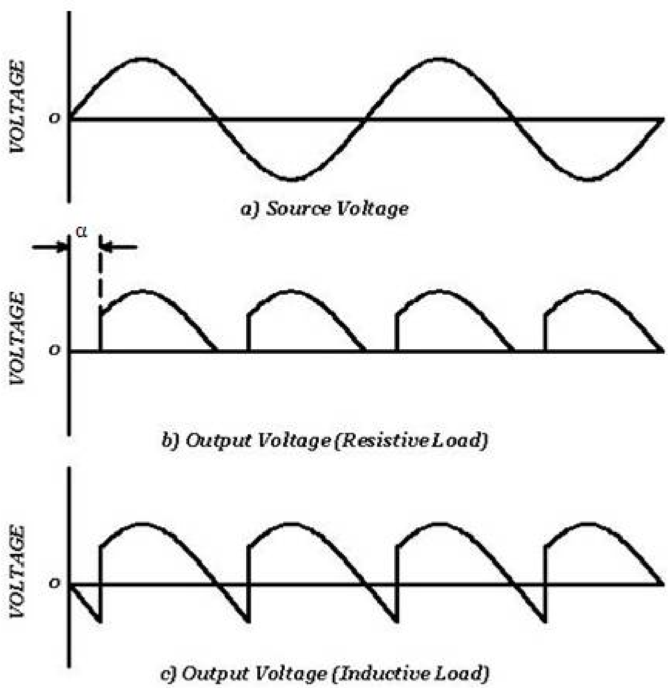

Fig 3 Voltage waveforms for R and RL Load

Result

Thus the operation of single phase fully controlled converter using R and RL loads have been studied and the output waveforms have been observed.

Post lab questions

Single phase full converter

1. What are the effects of source inductance on the output voltage of a rectifier?

2. Define firing angle, extinction angle.

3. What are the advantages of three phase rectifier over a single phase rectifier?

EXPERIMENT NO. 2
SERIES INVERTER

Name of the candidate	**:**	
Register Number	**:**	
Date of Experiment	**:**	

Sl. No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** e. Connection	10	
	f. Execution	10	
	g. Calculation	10	
	h. Evaluation	10	
	Total	**40**	
2	**Viva:-** c. Pre Lab (2.5) d. Post Lab(2.5)	5	

Pre-Lab Questions

Series Inverter

1. Why is this circuit called as series inverter?

2. What is the type of commutation for series inverter?

3. What is the configuration of inductor?

4. What is the principle of series inverter?

5. What are the disadvantages of series inverter?

Expt.No.2 Series Inverter

Aim

To study the operation of series inverter and to obtain variable AC from DC input.

Apparatus Required

i) Series inverter module

ii) Loading rheostat - 50Ω

iii) CRO

iv) Connection wire

Theory

A device that converts DC power into AC power at desired output voltage and frequency is called an inverter. If the thyristor commutation circuit of the inverter is in series with the Load, then the inverter is called “Series inverter. In this circuit, it is possible to turn-on thyristorT_p before the current through thyristor T_n has become zero and vice-versa. Therefore, the Modified Series Inverter can be operated beyond the resonance frequency (f_r) of the circuit. Inverter is operated at the resonance frequency (f_r) if the load current waveform has low frequency and should not have zero current interval. The inverter’s resonance frequency depends on the values of L, R and C in the circuit.The inverter unit consists of a power circuit and a firing circuit.

Firing Circuit

This part consists two pairs of alternate isolated trigger drive signal to fire two SCR’s alternatively. ON/OFF switch is provided for the trigger pulses which can be used to switch ON the inverter. Frequency of the inverter can be varied from 100 Hz to 1 KHz approximately.

Power Circuit

This part consists of two SCR’s, two diodes a center tapped inductor with tapings and 4 capacitors. Input supply terminal is provided with aON/OFF switch and a fuse. All the devices in this unit are mounted with proper heat sink, snubber circuit for dv/dt protection and a fuse in series with each device for short circuit protection.

Front Panel Details

1.	Frequency	:	Potentiometer to vary the inverter frequency. From 100 Hz to 1 KHz approximately.
2.	Gate, Cat	:	Trigger outputs to connect to Gate and Cathode of SCR
3.	ON / OFF	:	Switch for trigger outputs
4.	T_1 and T_2	:	Trigger outputs
5.	Power	:	Mains switch for firing circuit
6.	Vdc in	:	Terminals for DC input 30V/2A max from RPS
7.	ON / OFF	:	Switch for DC input
8.	Fuse	:	Fuse for dc input-2 Amps Glass Fuse
9.	T_1 and T_2	:	SCR's TY 616.12A / 600V
10.	D_1 and D_2	:	Diodes BYQ28. 4A/200V
11.	L_2, L_1, Lm, L_1, L_2	:	10mH – 5mH – 0 – 5mH – 10mH/2 Amps
12.	C_1 and C_1	:	6.8 μ farad / 100V
13.	C_2 and C_2	:	10 μ farad / 100V

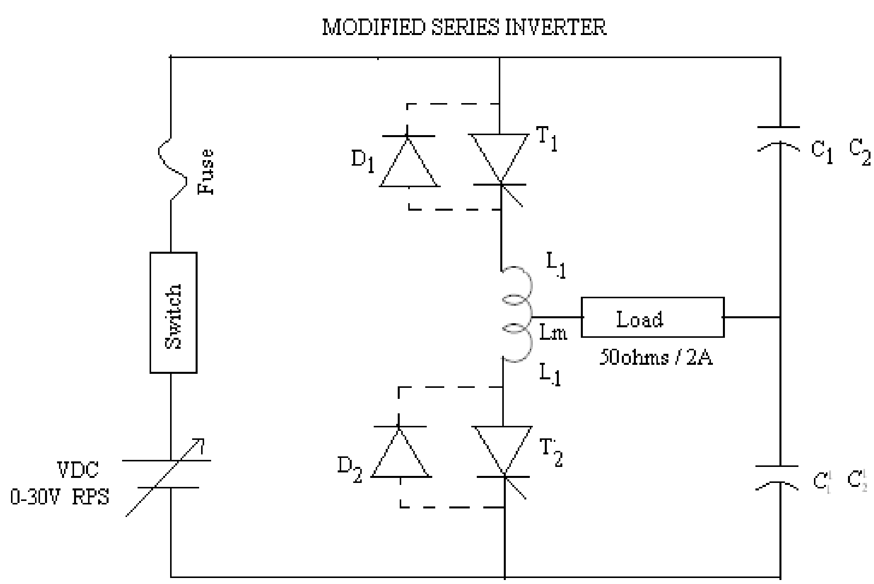

Fig 1 Modified Series Inverter

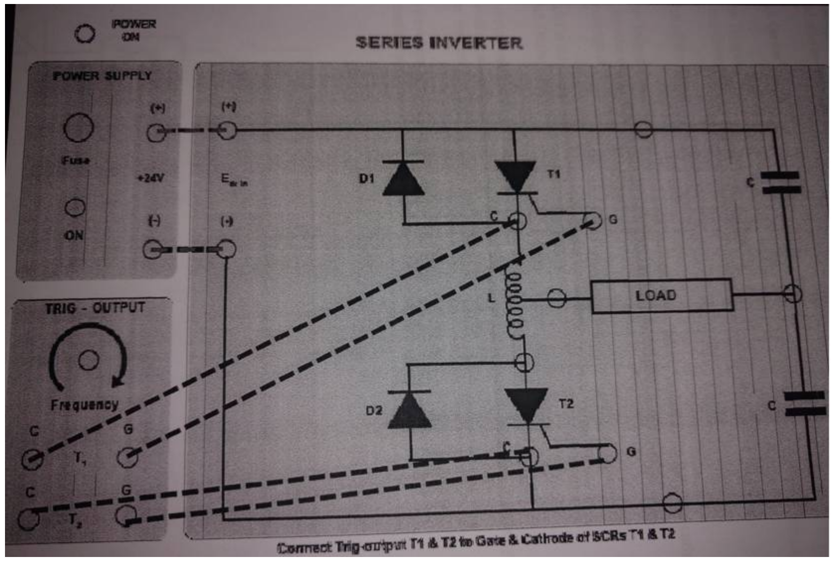

Fig 2 Patch connection in series inverter

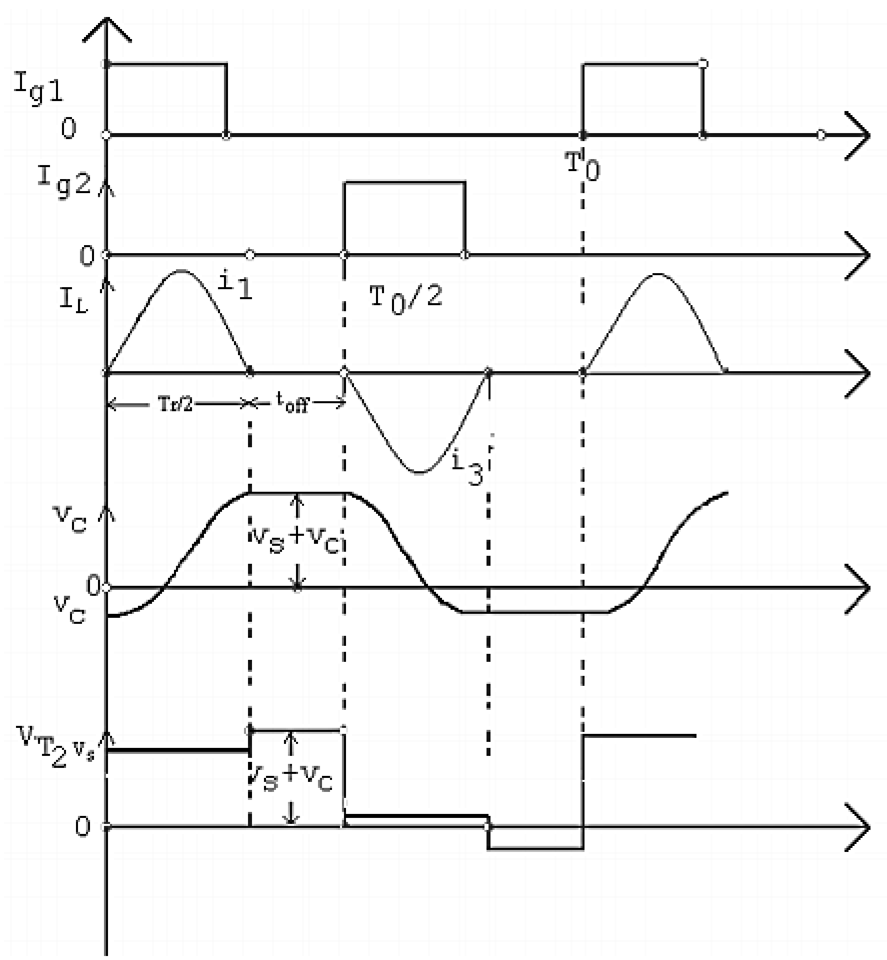

Fig 3 Voltage and Current Wave forms

Procedure

1. To begin with, switch on the power supply to input terminals of inverter circuit and also to input DC voltmeter of 30 V
2. Connections are made as shown Fig 2.
3. Now connect trigger outputs from the firing circuits to gate and cathode of SCRs T1 & T2.
4. Switch on the input DCSupply.
5. Now apply trigger pulses to SCRs and vary the frequency knob to observe voltage waveform across the load.
6. Measure Vrms& frequency of o/p voltage waveform.
7. Observe the voltages across T1 and T2, C1 and C2
8. Repeat the steps 6-7 by varying the firing angle

Observation Table

S.No	Amplitude (volt)	Ton (ms)	Toff (ms)

Result

Thus the operation of a series inverter is studied and waveforms are plotted.

Post-Lab Questions

Series Inverter

1. What is the need for a dead zone in an inverter circuit?

2. Up to what maximum voltage will the capacitor charge during circuit operation?

3. What is the amount of power delivered by capacitor?

4. What is the purpose of coupled inductors in half bridge resonant inverters?

5. List various types of resonant pulse inverters?

EXPERIMENT NO. 3

SINGLE PHASE CYCLOCONVERTER

Name of the candidate	**:**	
Register Number	**:**	
Date of Experiment	**:**	

Sl.No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** i. Connection	10	
	j. Execution	10	
	k. Calculation	10	
	l. Evaluation	10	
	Total	**40**	
2	**Viva:-** e. Pre Lab (2.5)	5	
	f. Post Lab(2.5)		

Pre-lab Questions
Single Phase Cycloconverter

1. State the difference between step up and step down Cycloconverter.

2. List various types of cycloconverter.

3. Write the expression for output voltage for cycloconverter.

Expt.No.3 Single Phase Cycloconverter

Aim

To conduct experiment on a single phase cycloconverter and study its performance with
R-load

Apparatus Required

1. Cycloconverter trainer kit
2. Patch chord
3. CRO

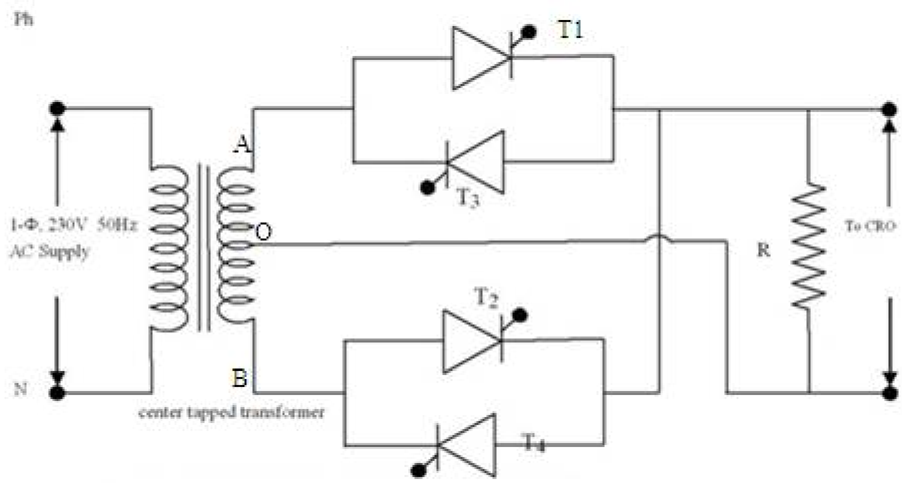

Fig1. Single phase to Single phase Mid-point Cycloconverter

Theory

Circuit diagram of 1-φ cycloconverter with R load is shown in Fig 1.For understanding the operation, the load is assumed to be resistive for simplicity. It consists of a single phase transformer with mid tape on the secondary winding and four thyristors T1, T2, T3&T4.Two of these thyristors T1, T2 are responsible for generating positive halves and formthe positive group. The other two T3, T4 are for negative group.

During the positive half cycle of supply voltage, when point A is positive with respect to O, SCR T1 and T4 are forward biased from $\omega t = 0$ to $\omega t = \pi$. SCR T1 is turned on at $\omega t = 0$ and the current flows through positive point A-T1-load and negative O. Load voltage follows the positive envelope of the supply voltage. In the negative half cycle of supply voltagewhenpoint B is positive with respect to point O,SCR T1 is turned off and SCR T2 is triggered at $\omega t = \pi$. In this condition, the current flows through B-T2-load-O.

The flow ofthe current direction is same as in the first case. During the positive half of secondcycle, when point O is positive with respect to B, SCR T4 is gated at $\omega t = 2\pi$. In this condition the load current flows through O-load-T4-B.Thus the direction of load current is reversed. Similarly in the negative half of secondcycle, when point O is negative with respect to B, T4 is turnoff due to natural commutation and T3 is triggered at $\omega t = 3\pi$. Thus, the load current flows through O-load-T3-A. The direction of load current is same as in previous case. In this manner, two negative half cycles of load voltage, equal to the number of two positive half cycles are generated. Now T1 is again triggered to generate further two positive half cycles of load voltage and so on. Waveform of mean output voltage V_o is shown in Fig 2. As a result, for two half cycles of source frequency f_s there is one half cycle of output frequency f_0. It is seen from the output voltage waveform, input frequency is reduced to ½ times across the load. Input and output waveforms are shown in Fig 2.

Similarly we can also obtain output voltage with a frequency of f_s/ 3, f_s/ 4 etc…

The frequency of the output voltage (f_o)=1/T, where T is the time period.

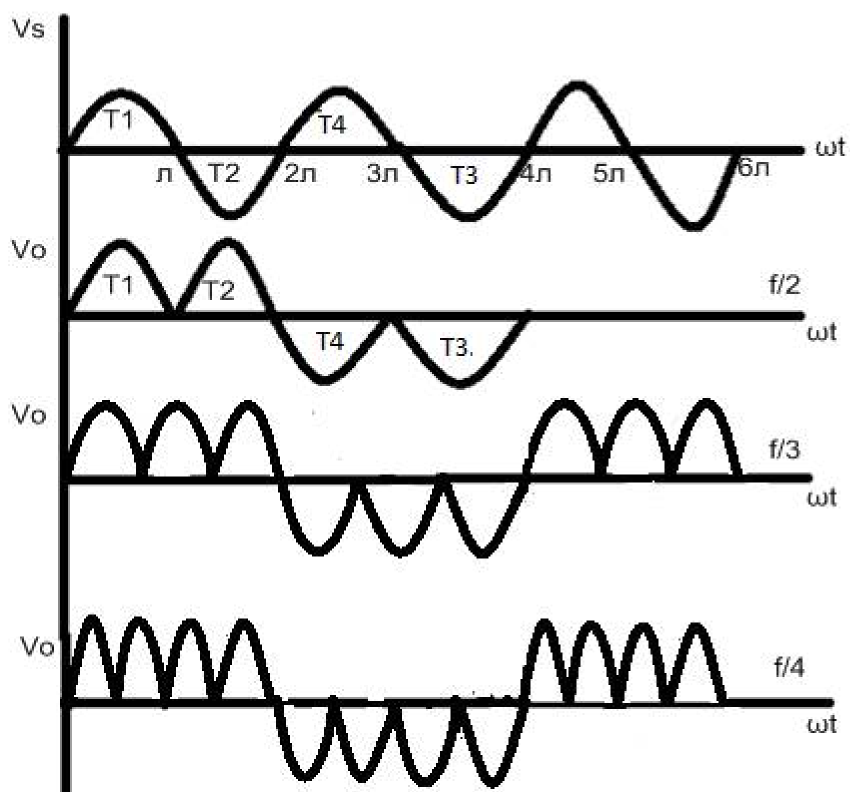

Fig 2 Output Volatge Waveform

Procedure

1. Connect the circuit as shown in Fig.1

2. Connect CRO

3. Switch ON the supply and note down the frequency of input voltage from the CRO.

3. Fix a value of the firing angle, Ex. Say $\alpha = 0^{O}$ and observe the output waveform in CRO

4. Measure the time period from the observed output voltage

5. Calculate the practical value of output frequency by reciprocating the value of time period

6. Repeat the above process from step 3 to 5 for frequency division of 3 and 4.

7. Now repeat step 3 to 6 by varying the firing angle from say $\alpha = 0^{O}$ to $\alpha = 30^{O}$

Result

Thus the operation of a cycloconverter is studied and the output waveforms are observed for various firing angle and frequencies.

Post-lab Questions

Single Phase Cycloconverter

1. For an output frequency equal to one third of the input frequency, Sketch output voltage waveform for a firing angle of 30 degree

2. In a diagrammatic representation differentiate mid-point and bridge type cycloconverter.

3. What is Load commutated cycloconverter?

EXPERIMENT NO.4

CUK CONVERTER

Name of the candidate	**:**	
Register Number	**:**	
Date of Experiment	**:**	

Sl.No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** m. Connection	10	
	n. Execution	10	
	o. Calculation	10	
	p. Evaluation	10	
	Total	**40**	
2	**Viva:-** g. Pre Lab (2.5) h. Post Lab (2.5)	5	

Pre-Lab Questions

CUK Converter

4. What is a cuk converter?

5. How the output voltage can be controlled in the cuk converter?

6. What is the difference between buck-boost regulators and cuk regulators?

7. What are the disadvantages of Cuk converter?

8. What is the advantage of Cuk converter over Buck-boost, boost converters?

Expt. No. 4 CUK Converter

Aim

To study and analyze the operation of CUK converter with different duty cycles and input voltages

Apparatus Required

S.No.	ITEM	RANGE	TYPE	QUANTITY
1	Cuk ConverterTrainer Kit	10V-16V	-	1
2	CRO	20MHZ	-	1
3	Patch Chord			10

Theroy

A non-isolated Ćuk converter comprises two inductors, two capacitors, a switch (usually a transistor), and a diode. Its schematic can be seen in figure 1. It is an inverting converter, so the output voltage is negative with respect to the input voltage.

The capacitor C_1 is used to transfer energy and is connected alternately to the input and to the output of the converter through the commutation of the transistor and the diode.

The two inductors L_1 and L_2 are used to convert respectively the input voltage source (V_{in}) and the output voltage source (C_2) into current sources. At a short time scale an inductor can be considered as a current source as it maintains a constant current. This conversion is necessary because if the capacitor were connected directly to the voltage source, the current would be limited only by the parasitic resistance, resulting in high energy loss. Charging a capacitor with a current source (the inductor) prevents resistive current limiting and its associated energy loss.

The Ćuk converter can either operate in continuous or discontinuous current mode. However, unlike these converters, it can also operate in discontinuous voltage mode (the voltage across the capacitor drops to zero during the commutation cycle).

When switch is in OFF state, the inductor currents flow through the diode. Capacitor C_1 is charged through the diode by energy from both the input and L_1. The current I_{L1} decreases, because V_{c1} is larger than V_d .Energy stored in L_2 feeds output and therefore I_{L2} decreases (Ref Fig.2).

When switch is in ON state, V_{C1} reverse biases the diode. I_{L1} and I_{L2} flows through the switch. As V_{C1}> V_0, C_1 discharges through the switch, transferring energy to the output and L_2 and therefore I_{L2} increases. The input feeds energy to L_1 causing I_{L1} to increase (Ref Fig.3).

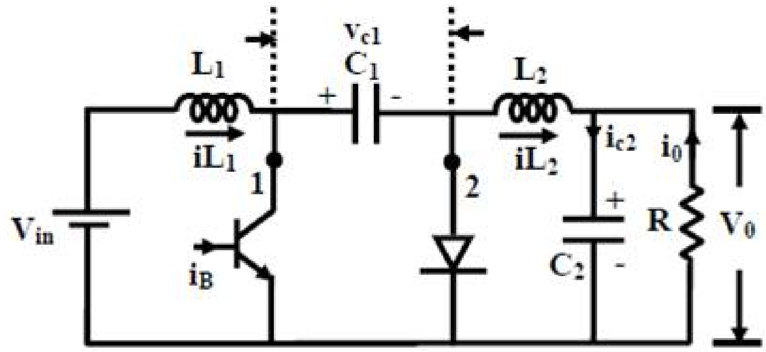

Fig 1 Schematic diagram of Cuk Converter

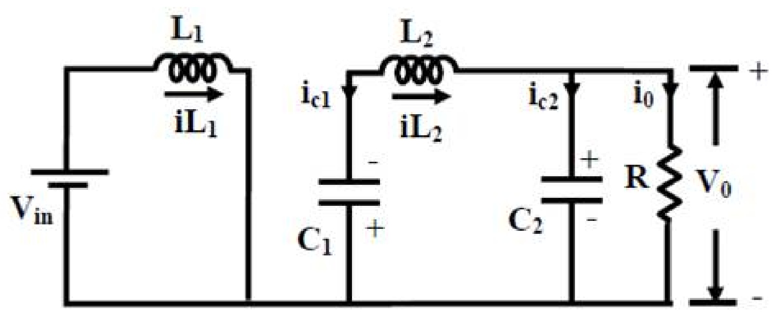

Fig 2 Equivalent circuit of an conductor when a) $0 < t \leq DT$

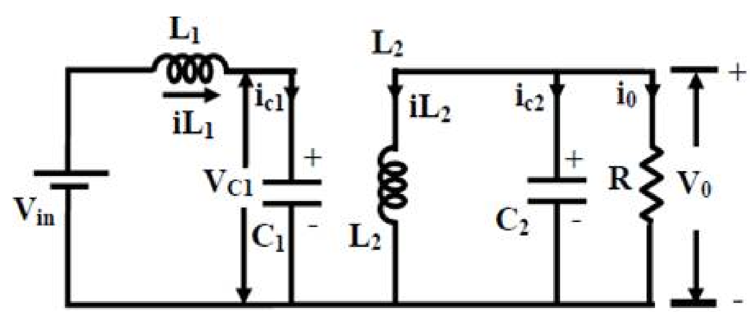

Fig 3 Equivalent circuit of an conductor when b) $DT < t \leq T$

Expression for average output voltage and inductor currents

Applying volt-sec balance across L_1

$$V_{in}DT+(V_{in}-V_{c1})T = 0 \quad (1)$$

Therefore

$$V_{in}(1-D)V_{c1} = 0$$

or

$$V_{c1} = \frac{V_{in}}{1-D} \qquad (2)$$

Applying volt-sec balance across L_2

$$(V_0 + V_{c1})\, DT + V_0(1-D)T = 0 \qquad (3)$$

or $$V_0 + DV_{c1} = 0 \qquad (4)$$

or $$V_0 = -\frac{DV_{in}}{1-D} \qquad (5)$$

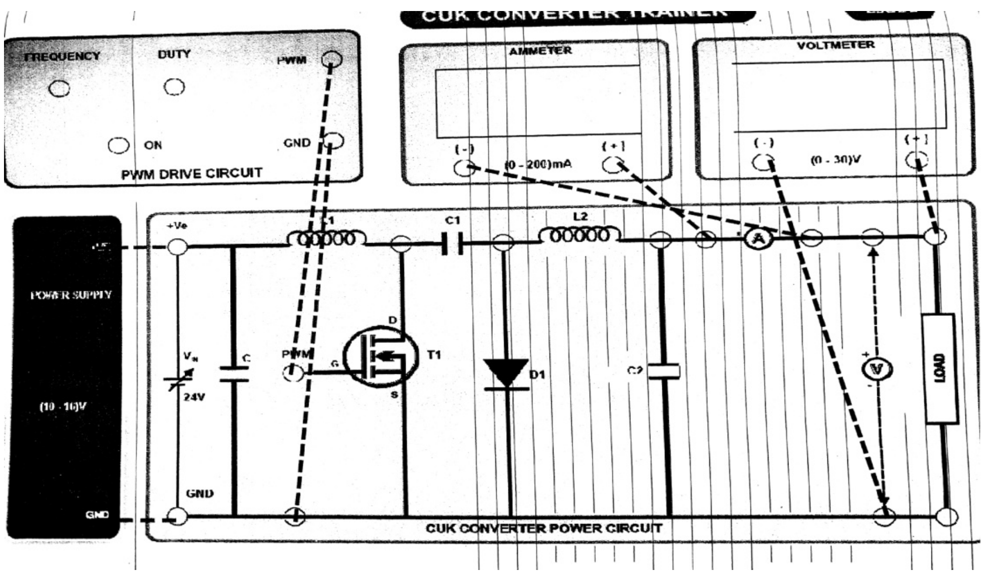

Fig 4 Patch connection details in CUK converter

Procedure

1. Connect the input power supply to the cuk converter module as per connection details.
2. Connect the PWM Drive out to the input of cuk circuit i.e., gate of MOSFET as per patch.

3. Connect the digital voltmeter at the output terminals marked voltmeter as per patch connections.
4. Connect the digital ammeter.
5. Now switch on the trainer.
6. Keep input power supply to a particular value of voltage.
7. Keep the duty cycle to minimum.
8. Now measure the output voltage and current.Observe the waveforms in CRO.
9. Vary the duty cycle in steps and observe the output voltage and current.
10. Repeat the above procedure for different settings of duty cycle say 30%, 60% and 90%.

Tabular column

For Vin = ----- V

S.No	Duty Cycle	Output Voltage (V)	Remarks

For Duty cycle D= ------%

S.No	Input Voltage (V)	Output Voltage (V)	Remarks

Result

Thus the performance of the CUK converter for various duty cyclesand input voltages is observed.

Post lab questions

CUK Converter

4. What are the advantages of CUK converter?

5. What type of Dc-Dc converter can be preferred for lower and high voltage applications?

6. What are the applications of Cuk converter?

7. What are the types of switch mode converters?

EXPERIMENT NO. 5

THREE PHASE PWM INVERTER

Name of the candidate	**:**
Register Number	**:**
Date of Experiment	**:**

Sl.No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** q. Connection	10	
	r. Execution	10	
	s. Calculation	10	
	t. Evaluation	10	
	Total	**40**	
2	**Viva:-** i. Pre Lab (2.5)	5	
	j. Post Lab(2.5)		

Pre-Lab Questions

Three Phase PWM Inverter

9. What is meant by Inverter?

10. Why thyristors are not preferred in Inverter?

11. What is meant by PWM Control?

12. What are the disadvantages of the harmonic present in the inverter system?

13. Compare CSI and VSI?

Expt.No.5 Three Phase PWM Inverter

Aim

To obtain three phase output wave forms for three phase PWM inverter

Apparatus Required

S.No.	ITEM	RANGE	TYPE	QUANTITY
1	IGBT Based PWM inverter Kit	220/10A		1
2	CRO	20MHZ		1
3	Patch Chord			10
4	Load rheostat	50Ω/5A		1

Theory

For providing adjustable frequency power, three phase inverters are more common than single phase inverters. They take their dc supply from a battery or from a rectifier. A basic three phase inverter is a six step bridge inverter. It uses six semi conductor devices as switches. A step is defined as a change in the firing from one switch to the next switch in proper sequence. For one cycle of 360 degree, each step would be of 60 degree interval. By gating the switches at regular intervals of 60 degree, a three phase ac voltages can be synthesized at the output terminals. Fig1 shows the circuit diagram of three phase inverter. Presently Insulated gate bipolar transistors (IGBTs) are considerably used in 3-phase inverters that have numerous applications. IGBTs have the advantages of high input impedance as the gate is insulated, has a rapid response ability, good thermal stability, simple driving circuit, good ability to withstand high voltage, snubber-less operation, and controllability of switching behavior providing reliable short-circuit protection. IGBT is a voltage controlled device, which gives it the ability to turn ON/OFF very quickly.

There are two possible ways of gating the switches. In one pattern, each switch conducts for a period of 180 degree and in the other each switch conducts for a period of 120 degree.

When the switch S_1 is switched on, terminal A is connected to the positive terminal of the dc input voltage. When the switch S_4 is switched on, terminal A is brought to the negative terminal of the dc source. There are six modes of operation in a cycle and the duration of each mode is 60^o.The devices are numbered in the sequence of gating the switches (e.g., 612,123,234,345, 456, and 561).

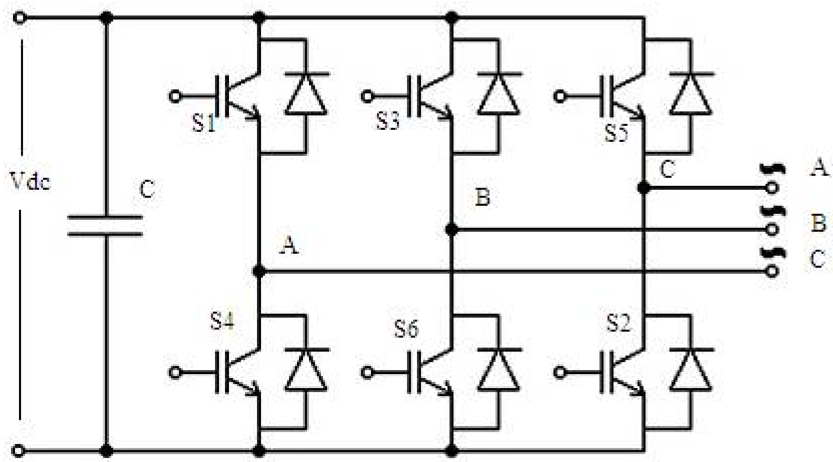

Fig 1 Three Phase Inverter

In each step, three switches are conducting one from upper group and two from the lower group or two from the upper group and one from the lower group. The switching sequence and the synthesized voltages for 180^omode of conduction are shown in Table 1.The same is repeated for 120^omode of conduction also.

Table 1Switching sequence and output voltages

Time interval	Name of the conducting switches	Phase voltages			Line voltages		
		A	B	C	V_{ab}	V_{bc}	V_{ca}
0^o to 60^o	5,6,1	Vs/3	-2Vs/3	Vs/3	Vs	-Vs	0
60^o to 120^o	6,1,2	2Vs/3	-Vs/3	-Vs/3	Vs	0	-Vs
120^o to 180^o	1,2,3	Vs/3	Vs/3	-2Vs/3	0	Vs	-Vs
180^o to 240^o	2,3,4	-Vs/3	2Vs/3	-Vs/3	-Vs	Vs	0
240^o to300^o	3,4,5	-2Vs/3	Vs/3	Vs/3	-Vs	0	Vs
300^o to360^o	4,5,6	-Vs/3	-Vs/3	2Vs/3	0	-Vs	Vs

Fourier series expansion of line to neutral voltage is given by

$$V_{ao} = \sum_{n=6k\pm1,}^{\infty} \frac{2V_S}{n\pi} \sin\ n(\omega t)$$

$k = 0,1,2.....$

The three line output voltages can be described by the Fourier series as follows:

$$V_{ab} = \sum_{n=1,3,5,}^{\infty} \frac{4V_s}{n\pi} \cos\frac{n\pi}{6} \sin n(\omega t + \frac{\pi}{6})$$

$$V_{bc} = \sum_{n=1,3,5,}^{\infty} \frac{4V_s}{n\pi} \cos\frac{n\pi}{6} \sin n(\omega t - \frac{\pi}{2})$$

$$V_{ca} = \sum_{n=1,3,5,}^{\infty} \frac{4V_s}{n\pi} \cos\frac{n\pi}{6} \sin n(\omega t + \frac{5\pi}{6})$$

$$V_{Ln} = \frac{4V_S}{\sqrt{2}n\pi} \cos\frac{n\pi}{6}$$

$$V_{Ln} = \frac{4V_S}{\sqrt{2}\pi} \cos\frac{\pi}{6} = 0.7797\, V_S$$

$$V_L = \left[\frac{1}{\pi}\int_0^{2\pi/3} V_S^2 d(\omega t)\right]^{1/2}$$

$$= \sqrt{\frac{2}{3}} V_S$$

$$= 0.8165 V_S$$

$$V_p = \frac{V_L}{\sqrt{3}} = \frac{\sqrt{2}}{3} V_S = 0.4714 V_S$$

$$V_{p1} = \frac{2V_S}{\sqrt{2}\pi} = 0.4502 V_S = \frac{V_{L1}}{\sqrt{3}}$$

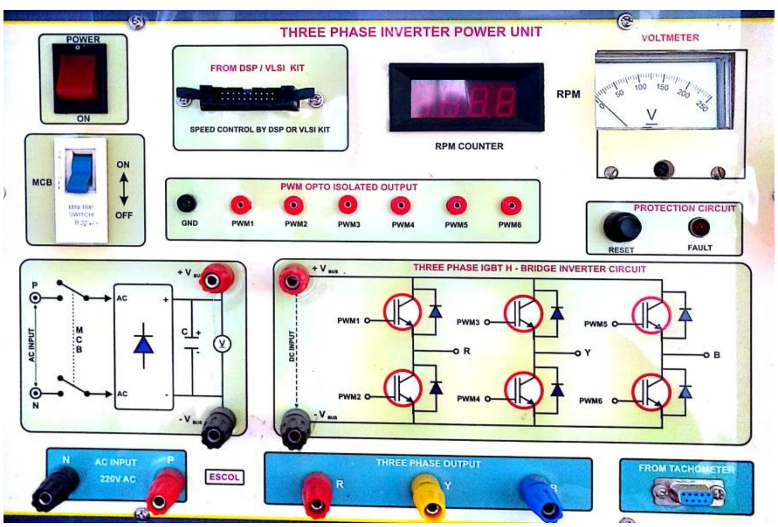

Fig 2 Front Panel of Three Phase Inverter

Procedure

1. Make the connection as per the circuit diagram.
2. Connect the gating signal from the inverter module.

3. Switch ON the supply.
4. Set the frequency knob to a particular frequency.
5. Observe the input and output waveforms for 180° conduction mode and 120° conduction mode in the CRO.
6. Trace the output line and phase voltage waveforms in a graph to understand the operation of 180° and 120° mode of conduction.

Tabular Column

S.No.	Output Voltage (V)	Time (ms)	Modulation Index

Model Graph

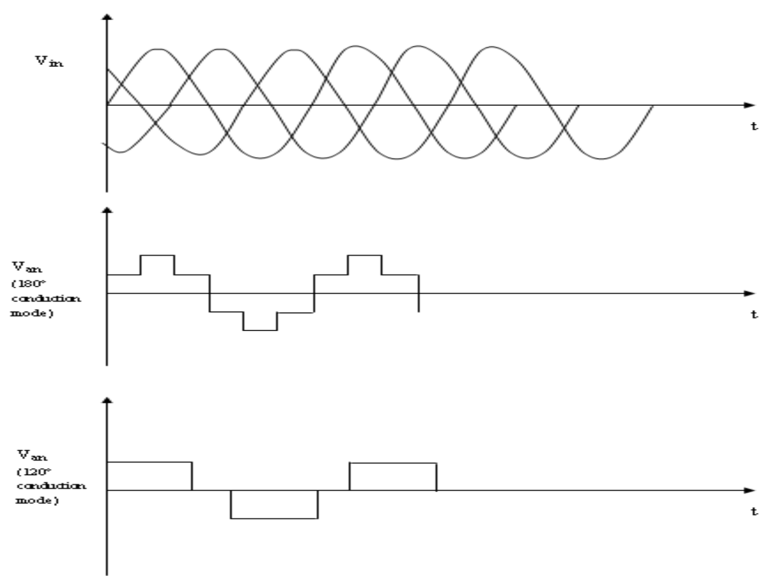

Fig 3 Phase Voltages for 180 and 120 degree mode of operation

Result

Thus the operation of three phase inverter is studied and output line and phase voltage waveforms were obtained.

Post lab questions

Three Phase PWM Inverter

8. What is dead time in inverter?

9. What is the drawback of PWM Control Technique?

10. State the differences between 180 and 120 Degree Mode Conduction?

11. What are the applications of Three Phase PWM Inverter?

12. In what way IGBT is more advantageous than BJT and MOSFET?

EXPERIMENT NO. 6

VOLTAGE COMMUTATED CHOPPER

Name of the candidate	**:**	
Register Number	**:**	
Date of Experiment	**:**	

Sl.No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** u. Connection	10	
	v. Execution	10	
	w. Calculation	10	
	x. Evaluation	10	
	Total	**40**	
2	**Viva:-** k. Pre Lab (2.5)	5	
	l. Post Lab(2.5)		

Pre-Lab Questions

Voltage Commutated Chopper

1. What are the other names of this circuit?

2. List the commutating components of this circuit?

3. Name the different types of commutated choppers?

4. Give the expression for commutating elements L and C for the voltage commutated chopper.

5. What is the purpose of freewheeling diode?

Expt.No.6 Voltage Commutated Chopper

Aim

To study the performance of Voltage Commutated Chopper.

Apparatus Required

1. VCC trainer kit.
2. Patch chord
3. CRO

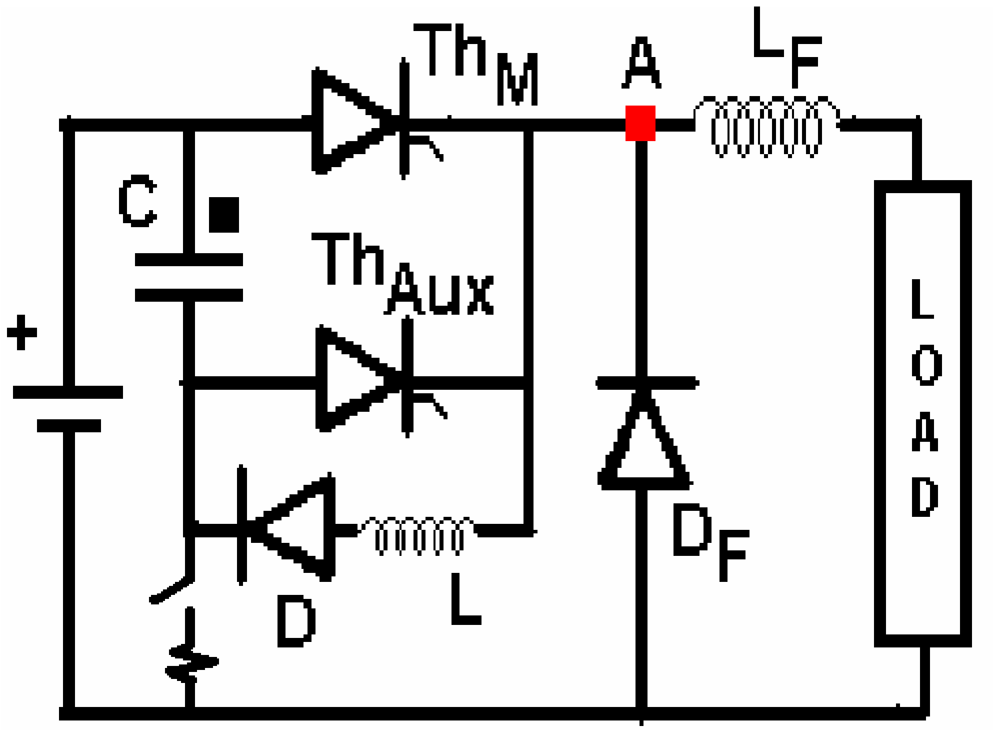

Fig 1 Circuit diagram of a voltage commutated chopper

Theory

In a voltage commutated thyristor circuit a voltage source is impressed across the SCR to be turned off, mostly by an auxiliary SCR. In the above diagram, thyristor T1 is the main power switch. Commutation circuitry is made up of by an auxiliary thyristor TA, capacitor C, diode D and inductor L. FD is the freewheeling diode connected across the RLE load. Working of the chopper circuit will take place only if capacitor C is precharged.

Mode-1

Thyristor T1 is fired at t = 0.The supply voltage comes across the load. Load current I_L flows through T_1 and load. At the same time capacitor discharges through T_1, D_1, L_1, & 'C' and the capacitor reverses its voltage. This reverse voltage on capacitor is held constant by diode D_1.

Capacitor discharge current = $i_c(t) = V_S = \sqrt{\frac{C}{L}} \sin \omega_o t$ where $\omega_o = \frac{1}{\sqrt{LC}}$

Mode-2

Thyristor T2 is now fired to commutate thyristor T1.When T2 is ON capacitor voltage reverse biases T1 and turns if off. The capacitor discharges through the load from –V to 0. Discharge time is known as circuit turn-off time. Capacitor recharges back to the supply voltage (with plate 'a' positive).This time is called the recharging time and is given by The total time required for the capacitor to discharge and recharge is called the commutation time and it is given by

$$t_d = \frac{Vs * C}{I_L}$$

At the end of Mode-2 capacitor has recharged to V_S and the freewheeling diode starts conducting.

Circuit turn off time is given as $t_c = \frac{Vc * C}{I_L}$ where I_L is the load current.

Mode-3

Auxiliary thyristor TA turns OFF since the capacitance is slightly over charged. FWD starts conducting and the load current decays

Mode-4

Capacitor has been overcharged i.e. its voltage is above supply voltage. Capacitor starts discharging in reverse direction. Hence capacitor current becomes negative. The capacitor discharges through V_S, FWD, D_1 and L. When this current reduces to zero D_1 will stop conducting and the capacitor voltage will be same as the supply voltage

Mode-5

Both thyristors are off and the load current flows through the FWD. This mode will end once thyristor T1 is fired

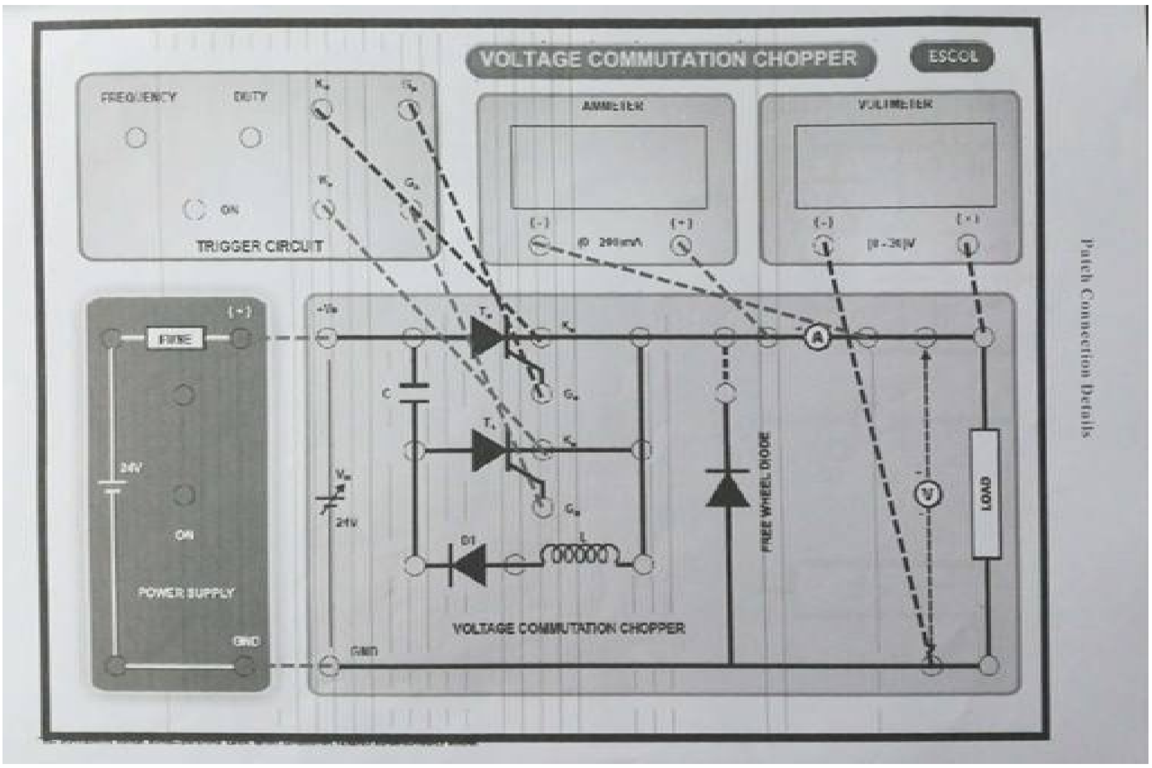

Fig 2 Patch connection details of a voltage commutated chopper

Procedure

1) Patch the Voltage Commutated Chopper as per the circuit diagram
2) Connect the CRO probe across the load terminals
3) Switch ON the trainer kit.
5) Switch ON the triggering pulse
6) Vary the duty ratio to observe the voltage across main SCR, capacitor, auxiliary SCR and load

Tabular Column

Across load: For V_{in} = Volts

S. No.	Output Voltage(V)	Time period (ms)		Duty cycle(%)
		Ton (ms)	Toff (ms)	

Across capacitor

S. No.	Voltage (V)	Time period (ms)		Duty cycle(%)
		Ton (ms)	Toff (ms)	

Across Main Thyristor (T_M)

S. No.	Voltage(V)	Time period (ms)		Duty cycle(%)
		Ton (ms)	Toff (ms)	

Model Graph

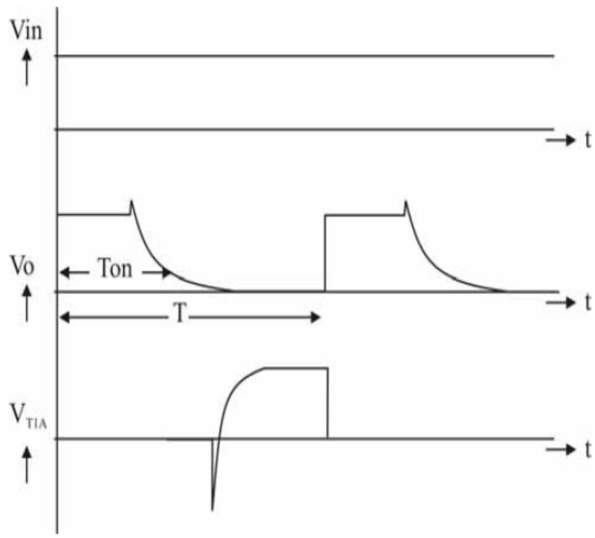

Fig 3 Input and output voltage waveforms

Result

Thus the operation of Voltage commutated chopper has been studied and the output waveforms have been observed for various duty cycle**.**

Post lab questions

Voltage commutated chopper

1. What are the initial conditions to be attained before the circuit can be operated?

2. What are the components required for commutating the thyristor?

3. What is the main disadvantage of this circuit?

4. In what mode do the diode and inductor operate?

5. Give the classification of the choppers.

EXPERIMENT NO.7
SINGLE PHASE AC VOLTAGE CONTROLLER USING TRIAC

Name of the candidate	**:**	
Register Number	**:**	
Date of Experiment	**:**	

Sl.No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** y. Connection	10	
	z. Execution	10	
	aa. Calculation	10	
	bb. Evaluation	10	
	Total	**40**	
2	**Viva:-** m. Pre Lab (2.5)	5	
	n. Post Lab(2.5)		

Pre-Lab Questions

Single Phase AC Voltage Controller using Triac

1. Why should the two trigger sources be isolated?

2. What are the advantages and the disadvantages of phase control?

3. What is phase control?

4. What are the advantages of bidirectional controllers?

5. What is meant by duty cycle in ON-OFF control method?

Expt.No.7-Single Phase AC Voltage Controller using Triac

Aim

To study the performance of single phase AC voltage controller using TRIAC.

Apparatus required

S.no.	Item	Range	Type	Quantity
1	Lamp	60W		1
2	AC voltage controller kit	-	-	1
3	CRO	-	-	
4	Patch Chord	-	-	10

Theory

Triac is a bidirectional thyristor with three terminals. Triac is the word derived by combining the capital letters from the words TRIode and AC. In operation, triac is equivalent to two SCRs connected in anti-parallel. It is used extensively for the control of power in ac circuit as it can conduct in both the direction. Its three terminals are MT1 (main terminal 1), MT2 (main terminal 2) and G (gate).

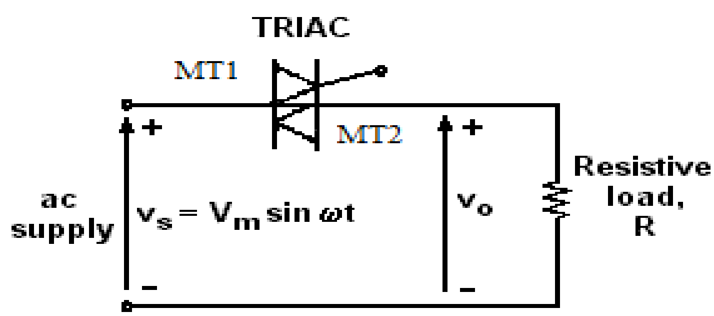

Fig 1 Single phase AC Voltage Controller

Circuit operation

During the period $0 < t \leq \pi/\omega$; The terminal MT1 is forward biased and The terminal MT2 is reverse biased. Let MT1 be triggered at an angle of α $0<\alpha<t< (\pi+\alpha)/\omega$ .Then the supply terminals are connected to the load through MT1 and the current starts flowing through the load via main thyristor. Therefore the supply appears across the load. During the period $\pi/\omega < t < (\pi+\alpha)/\omega$ MT1 is reverse biased and MT2 is forward biased and when we give trigger pulse at an angle of $(\pi+\alpha) /\omega$, MT2 starts conducting and the load terminals are connected to supply through MT2 hence the output voltage is the supply voltage from the instant of triggering. This repeats for every half cycle.

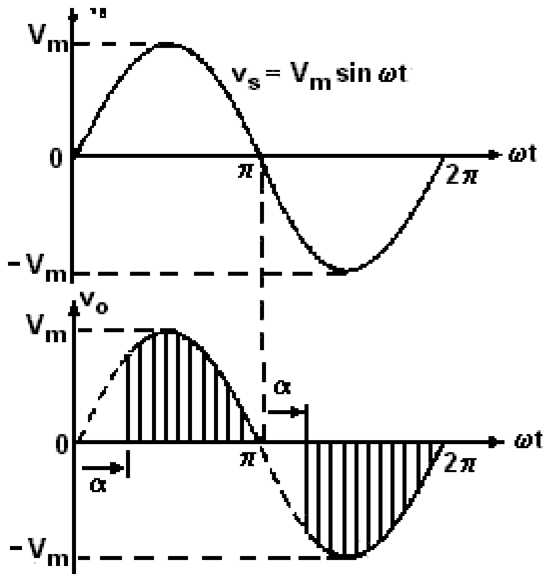

Fig 2 Input and Output Voltage Waveforms

Procedure

1. Connections are given as per the circuit diagram
2. Vary the firing angle "α"and Note the voltage across the triac and load using multimeter and CRO.

Tabular column

S.no.	Firing angle(α)	Output voltage(volts)	Time period(ms)
1			
2			
3			

Result

Thus the operation and performance of the single phase AC voltage controller using TRIAC was studied.

Post-lab questions

Single Phase AC voltage controller using TRIAC

1. What type of commutation is used in this circuit?

2. What are the effects of load inductance on the performance of AC voltage controllers?

3. What is extinction angle?

4. What are the disadvantages of unidirectional controllers?

5. What are the advantages of ON-OFF control?

EXPERIMENT NO. 8
PARALLEL INVERTER

Name of the candidate	**:**
Register Number	**:**
Date of Experiment	**:**

Sl. No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** cc. Connection	10	
	dd. Execution	10	
	ee. Calculation	10	
	ff. Evaluation	10	
	Total	**40**	
2	**Viva:-** o. Pre Lab (2.5)	5	
	p. Post Lab(2.5)		

Pre-Lab Questions

Parallel Inverter

1. What is parallel inverter? Why is it called so?

2. What is the purpose of capacitor in the parallel inverter?

3. What is the purpose of a transformer in the parallel inverter?

4. What is the type of commutation employed in parallel inverter?

5. What are the advantages of parallel resonant inverters?

Expt. No 8 Parallel Inverter

Aim

To study the operation of parallel inverter.

Apparatus Required

i) Parallel inverter kit

ii) Inductor

iii) Transformer

iv) CRO

Theory

The circuit shown in Fig 1 is a typical class C Parallel inverter. Assume SCR_2 to be ON and SCR_1 to be OFF. The commutating capacitor C is charged to twice the supply voltage and remains at this value until SCR_1 is turned on. When SCR_1 is turned on, the current flows through upper half of the primary SCR_1 and commutating inductance L. Since voltage across C cannot change instantaneously, the common SCR cathode point rises approximately to 24V dc and reverses biasesSCR_2. Thus SCR_2 turns off and C discharges through L, the supply circuit and then recharges in the reverse direction. The autotransformer action makes C to charge making now its upper point to reach +24V dc volts ready to commutate SCR_1, When SCR_2 is again turned on and the cycle repeats.

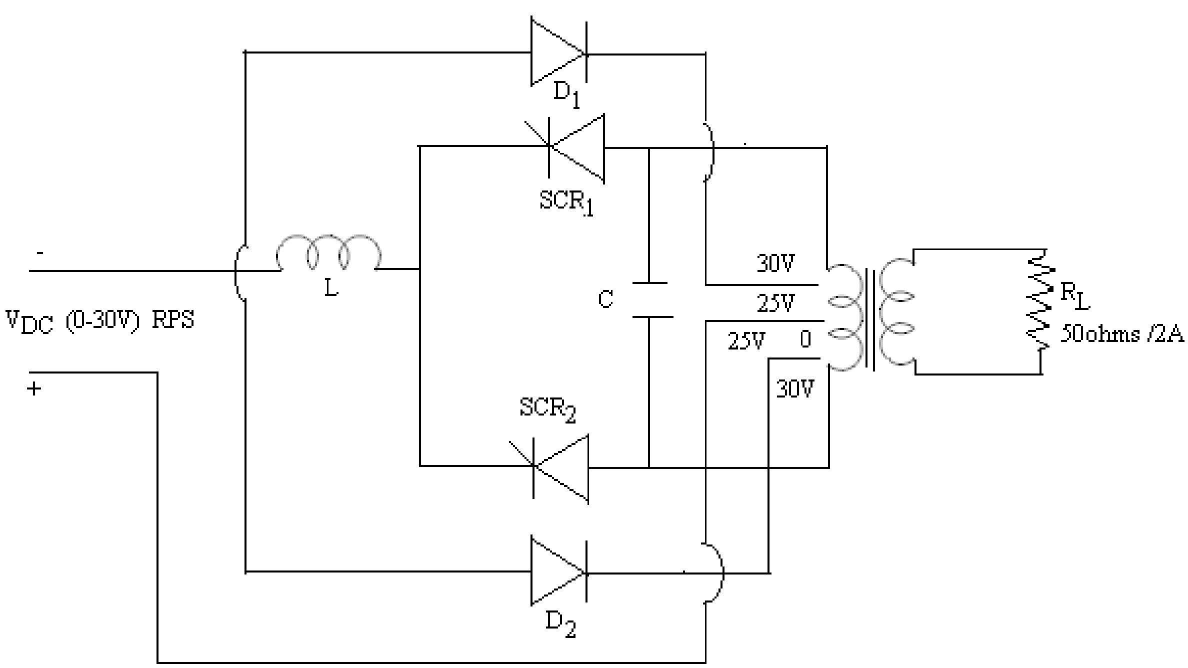

Fig 1 Parallel Inverter

Freewheeling diodes Dp and D_N assist the inverter in handling a wide range of loads and the value of C may be reduced since the capacitor now does not have to carry the reactive current. To dampen the feedback diode currents within the half period, feedback diodes are connected to tapping of the transformer at 25V tapping.

This module consists of two units – (1) Firing circuit and (2) Power circuit.

(1) Firing Circuit:

This unit generates two pairs of pulse transformer isolated trigger pulses to trigger two SCR's connected in center tapped transformer type parallel inverter. Frequency of the inverter can be varied from 75Hz to 200 Hz approximately.

(2) Power Circuit:

This unit consists of two SCR's, two freewheeling diodes, commutation inductor, commutation capacitor and a center tapped transformer to be inter connected to make parallel inverter. All the points are brought out to the front panel. A switch and fuse is provided for input DC supply. All the devices are mounted on proper heat sink. Each device is protected by snubber circuit.

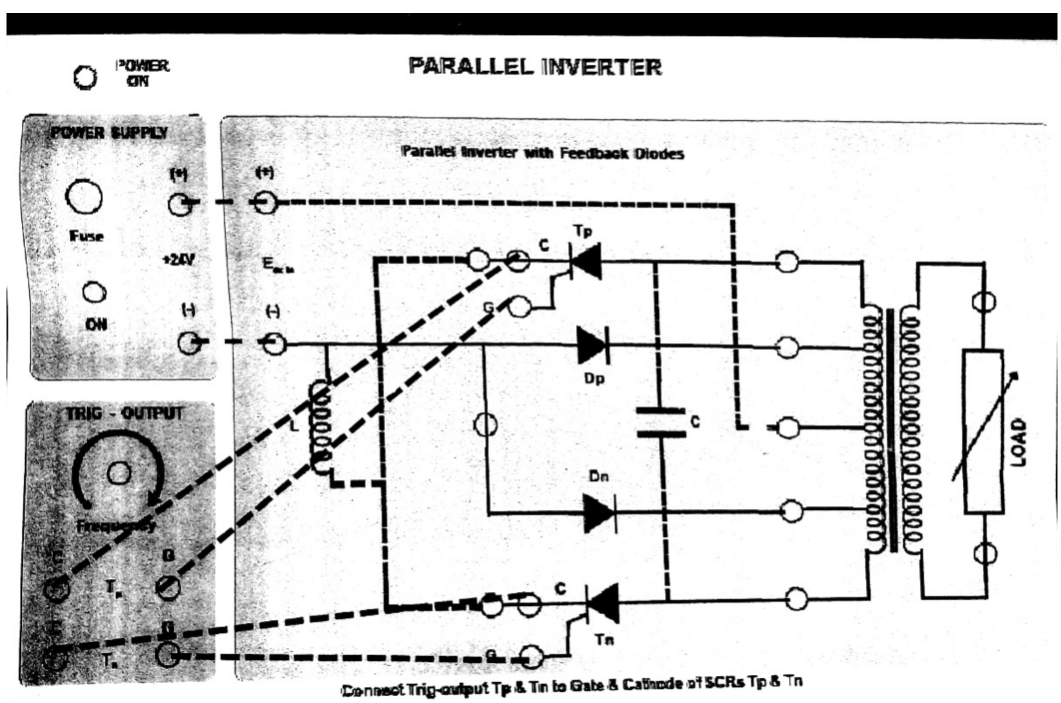

Fig 2 Front Panel of Parallel Inverter

Front Panel Details:

1.	Frequency	:	Potentiometer to vary the inverter frequency from 75Hz to 200Hz approximately
2.	ON / OFF	:	Switch for trigger outputs
3.	T_1& T_2	:	Trigger outputs
4.	Power	:	Mains switch for firing circuit
5.	V_{dc} in	:	Terminals for DC input from 30V/2A RPS unit
6.	ON	:	Switch for DC input
7.	T_p&T_n	:	SCR's 10A / 600V
8.	D_p&D_n	:	Diodes 10A/600V
9.	L	:	Inductance – 300μH/2A
10.	C	:	6.8μF/100V
11.	Load	:	Terminals to connect load.
12.	O	:	Transformer center tap point which should be Connected to positive of DC supply after fuse.
13.	Fuse	:	2A Glass fuse.
14.	Output Transformer	:	Primary – 30V-25V-25V – 30V Secondary – 0-30V/2Amps.

Procedure

1. Switch on the firing circuit. Observe the trigger outputs T_P and T_N by varying frequency potentiometer and by operating ON/OFF switch.
2. Then connect input DC supply to the power circuit. Connect trigger outputs to Gate and Cathode of SCR T_P& T_N.
3. Apply trigger pulses to SCR
4. Observe voltage waveforms across load. Output voltage is square wave only.
5. Vary the load, vary the frequency and observe waveforms.

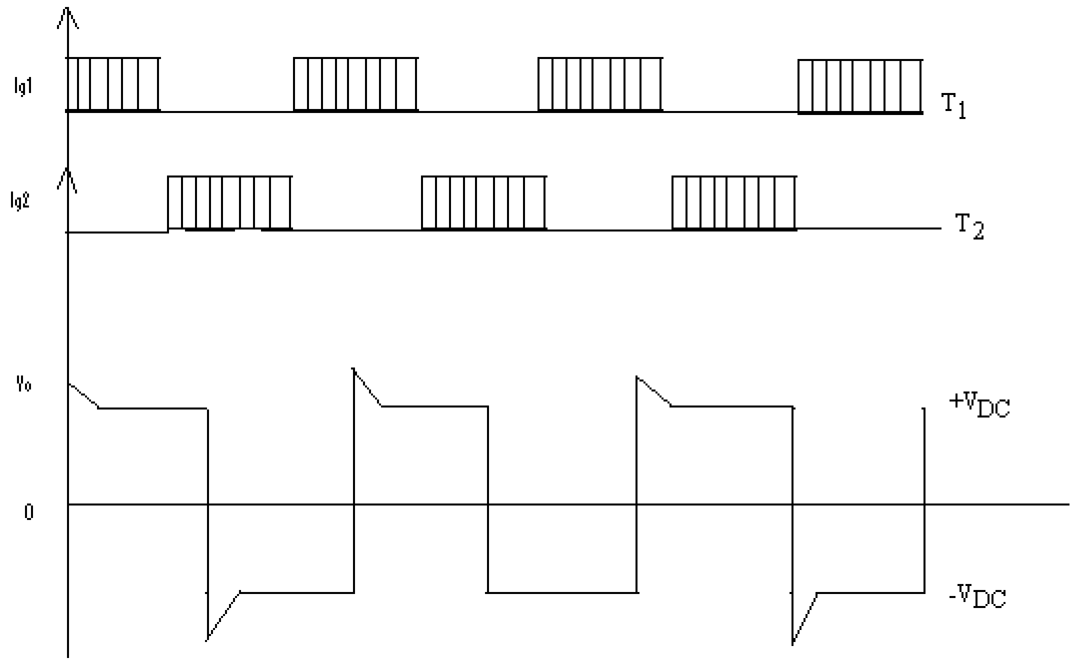

Fig 3 Triggering pulses and Output voltage waveform

Tabular Column

S.No.	**Frequency**	**Voltage Amplitude(V)**	**Time period(ms)**
1			
2			

Result

Thus the operation of a parallel inverter is studied and the output waveforms are measured and drawn.

Post Lab Questions

1. What is the purpose of the inductor in the parallel inverter?

2. During its operation, capacitor voltage reaches 2Vs. How?

3. What is the significance of the split phase transformer?

4. During operation, what is the voltage across primary winding of the transformer?

EXPERIMENT NO.9
SEPIC CONVERTER

Name of the candidate	**:**	
Register Number	**:**	
Date of Experiment	:	

Sl. No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** gg. Connection	10	
	hh. Execution	10	
	ii. Calculation	10	
	jj. Evaluation	10	
	Total	**40**	
2	**Viva:-** q. Pre Lab (2.5)	5	
	r. Post Lab(2.5)		

Pre-Lab Questions

SEPIC Converter

1. What do you mean by SEPIC?

2. Write the output voltage equation of SEPIC converter.

Expt. No.9 SEPIC Converter

Aim

To study the working of SEPIC Converter with various duty cycles

Apparatus Required

1. Power Electronics SEPIC (Trainer) kit
2. CRO
3. Connecting wires.

Theory

The Single-Ended Primary-Inductor converter (**SEPIC**) is a type of DC/DC converter allowing the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input. The output of the SEPIC is controlled by the duty cycle of the control transistor.

A SEPIC is essentially a boost converter followed by a buck-boost converter, therefore it is similar to a traditional buck-boost converter, but has advantages of having non-inverted output (the output has the same voltage polarity as the input), using a series capacitor to couple energy from the input to the output (and thus can respond more gracefully to a short-circuit output), and being capable of true shutdown: when the switch is turned off, its output drops to 0 V, following a fairly hefty transient dump of charge.

SEPICs are useful in applications in which a battery voltage can be above and below that of the regulator's intended output. For example, a single lithium ion battery typically discharges from 4.2 volts to 3 volts; if other components require 3.3 volts, then the SEPIC would be effective.

The schematic diagram for a basic SEPIC is shown in Fig1.

A SEPIC is said to be in continuous-conduction mode ("continuous mode") if the current through the inductor L1 never falls to zero. During a SEPIC's steady-state operation, the average voltage across capacitor C1 (V_{C1}) is equal to the input voltage (V_{in}). Because capacitor C1 blocks direct current (DC), the average current through it (I_{C1}) is zero, making inductor L2 the only source of DC load current. Therefore, the average current through inductor L2 (I_{L2}) is the same as the average load current and hence independent of the input voltage.

Looking at average voltages, the following can be written:

$$Vin = V_{L1} + V_{C1} + V_{L2}$$

Because the average voltage of V_{C1} is equal to V_{IN}, $V_{L1} = -V_{L2}$. For this reason, the two inductors can be wound on the same core. Since the voltages are the same in magnitude, their effects of the mutual inductance will be zero, assuming the polarity of the windings is correct. Also, since the voltages are the same in magnitude, the ripple currents from the two inductors will be equal in magnitude.

When switch S1 is turned on, current I_{L1} increases and the current I_{L2} goes more negative. (Mathematically, it decreases due to arrow direction.) The energy to increase the current I_{L1} comes from the input source. Since S1 is a short while closed, and the instantaneous voltage V_{L1} is approximately V_{IN}, the voltage V_{L2} is approximately $-V_{C1}$. Therefore, the capacitor C1 supplies the energy to increase the magnitude of the current in I_{L2} and thus increase the energy stored in L2.

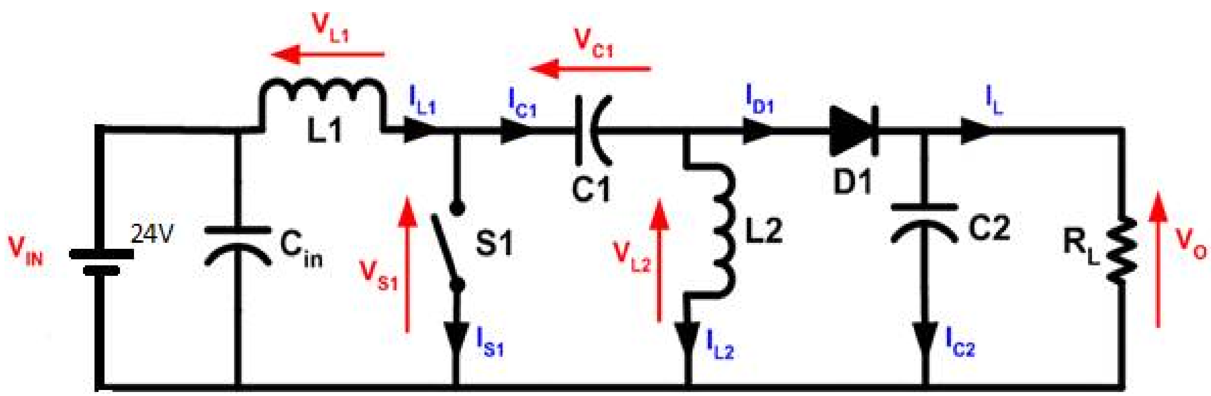

Fig 1SEPIC Converter

When switch S1 is turned off, the current I_{C1} becomes same as the current I_{L1}, since inductors do not allow instantaneous changes in current. The current I_{L2} will continue in the negative direction, in fact it never reverses direction. It can be seen from the diagram that a negative I_{L2} will add to the current I_{L1} to increase the current delivered to the load. Using Kirchhoff's Current Law, it can be shown that $I_{D1} = I_{C1} - I_{L2}$. While S1 is off, power is delivered to the load from both L2 and L1. C1, however is being charged by L1 during this off cycle, and will in turn recharge L2 during the on cycle.

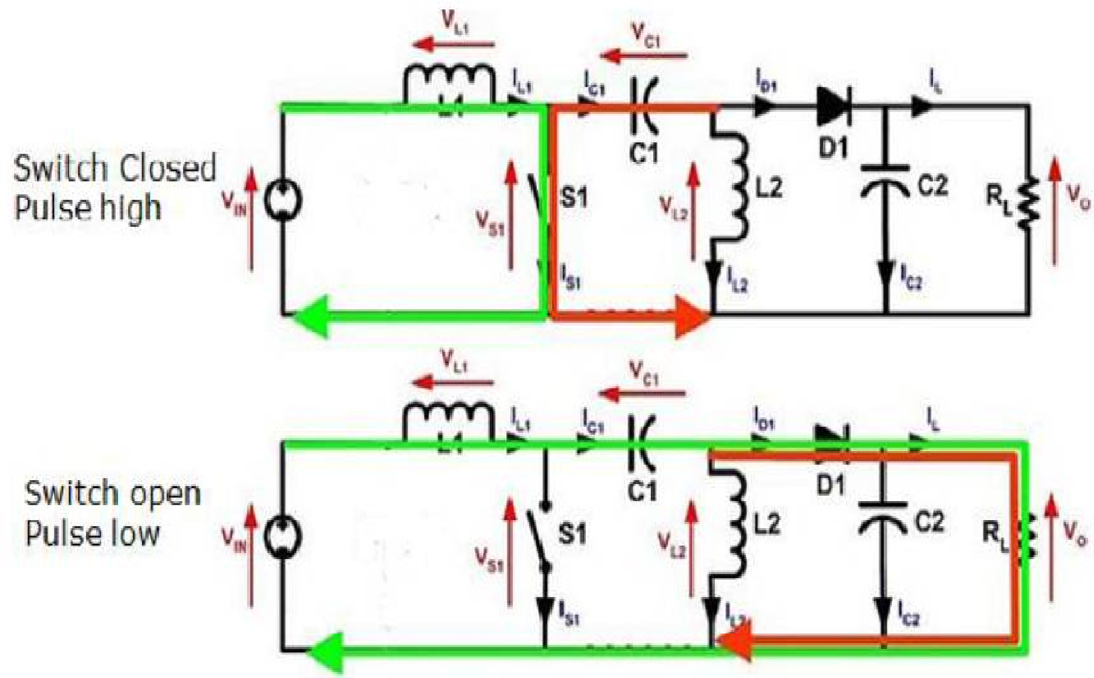

Fig 2 Operation of SEPIC converter

The capacitor C_{in} is required to reduce the effects of the parasitic inductance and internal resistance of the power supply. The boost/buck capabilities of the SEPIC are possible because of capacitor C1 and inductor L2. Inductor L1 and switch S1 create a standard boost converter, which generates a voltage (V_{S1}) that is higher than V_{IN}, whose magnitude is determined by the duty cycle of the switch S1. Since the average voltage across C1 is V_{IN}, the output voltage (V_O) is V_{S1} - V_{IN}. If V_{S1} is less than $2V_{IN}$, then the output voltage will be less than the input voltage. If V_{S1} is greater than $2V_{IN}$, then the output voltage will be greater than the input voltage

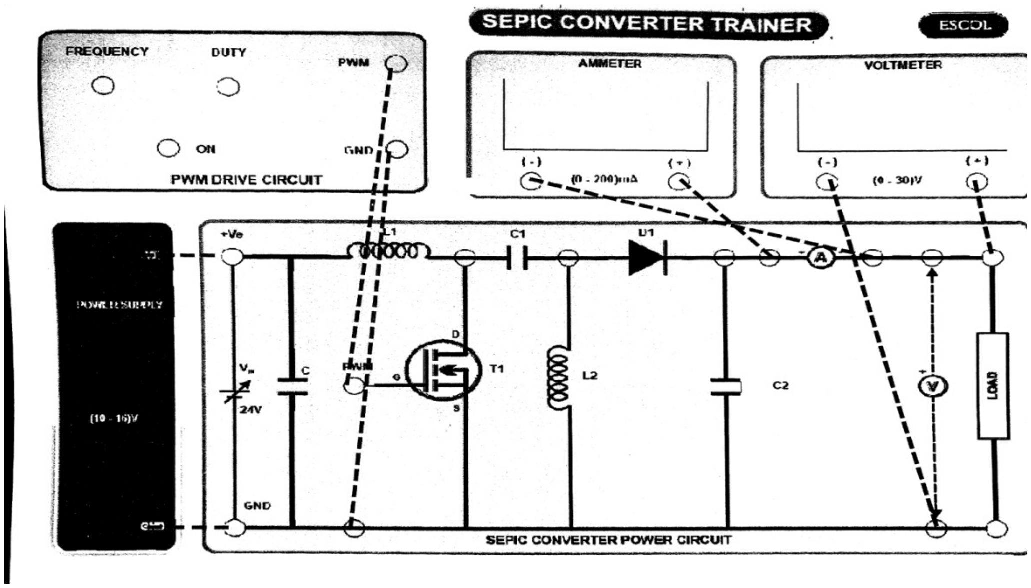

Fig 3 Patch connection details in SEPIC converter

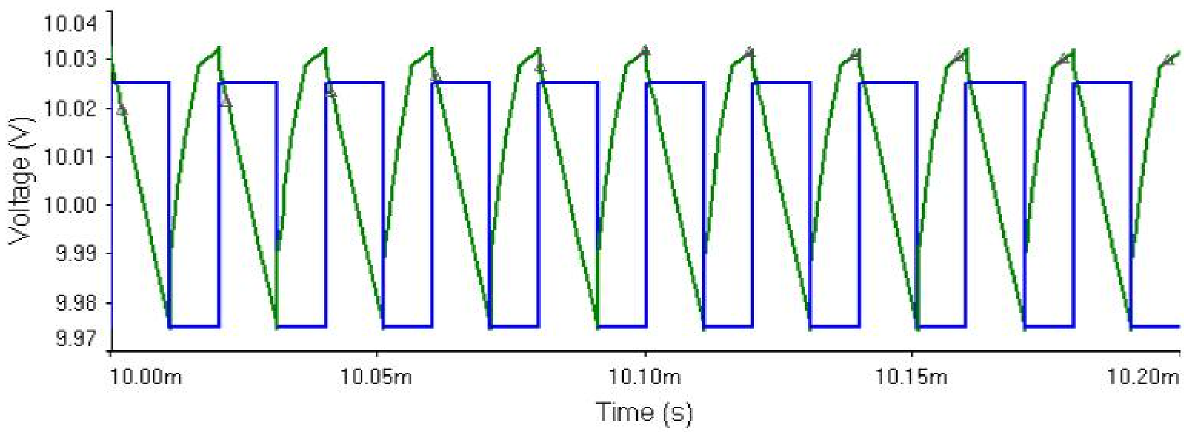

Fig 3 Output Voltage Waveform

Procedure

1. Make the connections as per the circuit diagram.
2. Connect CRO and multi-meter (in dc) across the load.
3. Now connect trigger outputs from the firing circuits to gate and cathode.
4. Connect DC input from a 24V regulated power supply.
5. Adjust the frequency knob and Keep the frequency constant.
6. Now apply trigger pulses to switch and observe voltage waveform across the load by varying Vin
7. Tabulate the readings in observation column.

8. Draw the waveforms observed in CRO. Also note the value of maximum amplitude Vm from the waveform.
9. Note down T_{ON} and T_{OFF} from the displayed waveform
10. Now repeat the steps 7 to 8 by varying duty cycle at constant Vin

Observation

Table 1

<table>
<tr><th>S.No</th><th>V_{in}</th><th>Duty Cycle</th><th>V_o</th><th>T_{on}</th><th>T_{off}</th></tr>
<tr><td></td><td rowspan="3"></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
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</table>

Table 2

<table>
<tr><th>S.No</th><th>V_{in}</th><th>Duty Cycle</th><th>T_{on}</th><th>T_{off}</th><th>V_o</th></tr>
<tr><td></td><td></td><td rowspan="4"></td><td></td><td></td><td></td></tr>
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</table>

Result

Thus the operation of SEPIC Converter have been studied and the output waveforms have been observed by varying duty cycles at different input voltages

Post lab questions

SEPIC Converter

1. What are the applications of SEPIC converter?

2. What are the advantages of SEPIC converter?

3. What are the disadvantages of SEPIC converter?

EXPERIMENT NO.10

CASCADED MULTILEVEL INVERTER

Name of the candidate	**:**
Register Number	**:**
Date of Experiment	:

Sl. No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** kk. Connection	10	
	ll. Execution	10	
	mm. Calculation	10	
	nn. Evaluation	10	
	Total	**40**	
2	**Viva:-** s. Pre Lab (2.5)	5	
	t. Post Lab(2.5)		

Pre-Lab Questions
Cascaded Multilevel Inverter

1. What is cascaded multilevel inverter?

2. What are the features of Cascaded Multilevel inverter?

3. What are the advantages of Cascaded Multilevel inverter?

4. What are the disadvantages of Cascaded Multilevel inverter?

5. Give the applications of Multilevel Converter?

Expt. No. 10 Cascaded Multilevel Inverter

Aim

To study the operation and performance of the cascaded multilevel inverter

Apparatus Required

(i) Cascaded 3 level inverter module

(ii) Power supply

(iii) DSO

(iv) Connection wires

(v) Regulated Power Supply

Theory

The cascaded inverter uses series strings of single-phase full-bridge (H-bridge) inverters to construct multilevel phase legs with separate dc sources. The output of H-bridge inverter shown in Fig. 1 has three discrete levels, results in a staircase waveform that is nearly sinusoidal even without filtering. A single H-bridge is a three-level inverter. Each single-phase full-bridge inverter generates three voltages at the output: $+V_{dc}$, 0 and $-V_{dc}$.

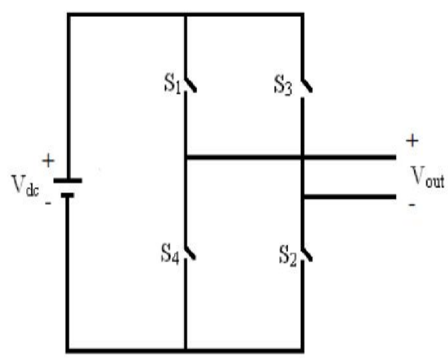

Fig. 1 Single H-Bridge Topology

The four switches S_1, S_2, S_3 and S_4 are controlled to generate three discrete outputs V_{out} with levels $+V_{dc}$, 0 and $-V_{dc}$. When S_1 and S_2 are ON, the output is $+V_{dc}$; when S_3 and S_4 are ON, the output is $-V_{dc}$; when either pair S_1 and S_3 (or) S_2 and S_4 are ON, the output is 0.

The circuit shown in Fig. 2 is a single-phase, seven-level cascaded H-bridge cell inverter realized by connecting three full bridge inverters in series. The output voltages for various switching stages are shown in Table 1.

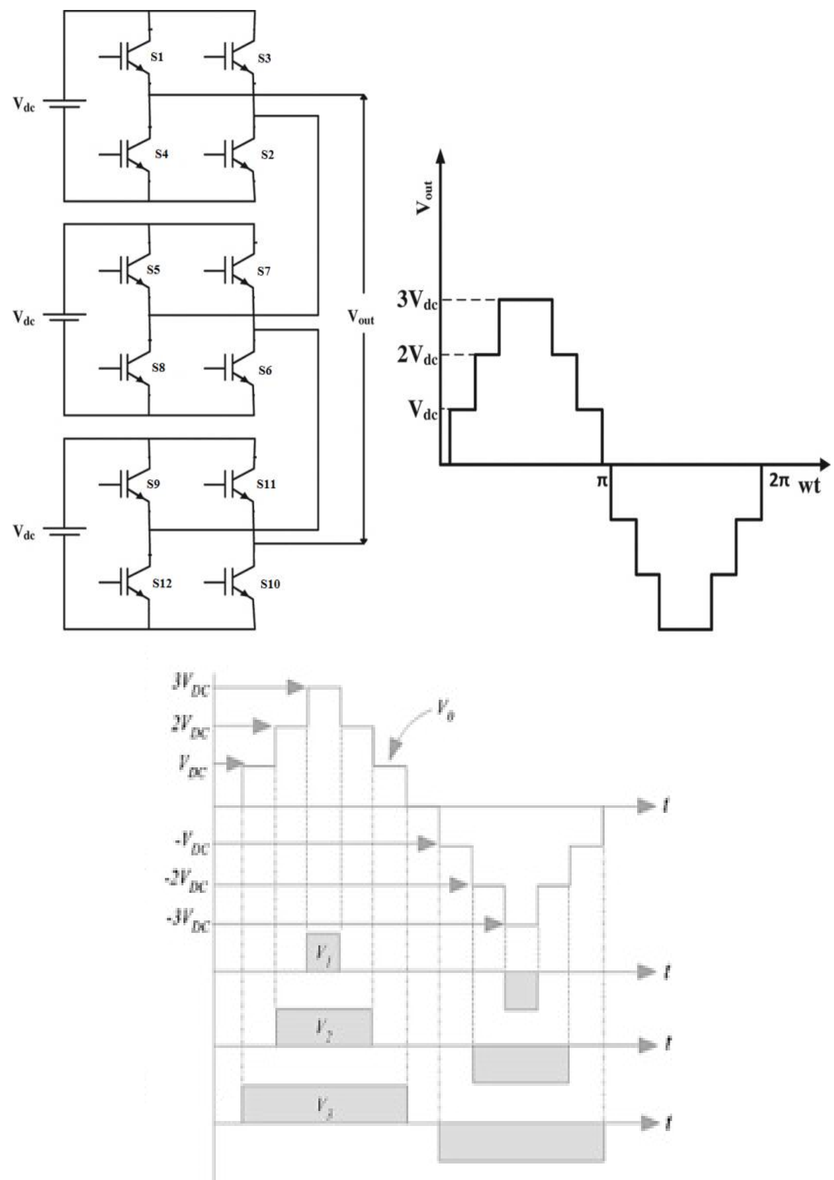

Fig. 2 Seven level cascaded inverter circuit and waveform

Table 1. Output voltage for various switching stages

Voltage (Vo)	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
0	0	1	0	1	0	1	0	1	0	1	0	1
V_{dc}	1	1	0	0	0	1	0	1	0	1	0	1
$2V_{dc}$	1	1	0	0	1	1	0	0	0	1	0	1
$3V_{dc}$	1	1	0	0	1	1	0	0	1	1	0	0
$-V_{dc}$	0	1	0	1	0	1	0	1	1	1	0	0
$-2V_{dc}$	0	1	0	1	0	0	1	1	0	0	1	1
$-3V_{dc}$	0	0	1	1	0	0	1	1	0	0	1	1

Procedure

1. Make connections as per circuit diagram
2. Connect CRO across the load
3. Switch ON the power supply
4. Vary the frequency and observe the waveform in CRO
5. Measure the time period and output voltage

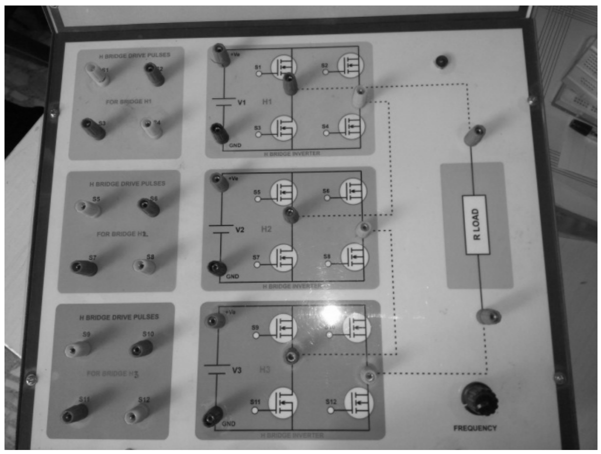

Fig. 3 Front Panel of Cascaded multilevel inverter

Observation Tables

S. No	Frequency	Output Voltage	Time period
1			
2			
3			
4			
5			

Modulation Index: ………………

S. No	Input Voltage	Output voltage	THD
1			
2			
3			
4			
5			

Input Voltage: ………………

S. No	Modulation Index	Output Voltage	THD

Result

Thus the operation of the cascaded multilevel inverter is studied and the output waveforms are observed for various switching frequencies.

Post Lab Questions
Cascaded Multilevel Inverter

1. What is the gain of the multilevel inverter?

2. How can the output frequency of the inverter?

3. Write short notes on Total Harmonic Distortion.

4. What Distortion Factor (DF)?

5. what is meant by lower order harmonic (LOH)

EXPERIMENT NO. 11

SIMULATION OF BOOST CONVERTER USING MATLAB

Name of the candidate	**:**	
Register Number	**:**	
Date of Experiment	**:**	

Sl.No.	Marks Split Up	Maximum Marks (45)	Marks Obtained
1	**Experiments:-** oo. Connection	10	
	pp. Execution	10	
	qq. Calculation	10	
	rr. Evaluation	10	
	Total	**40**	
2	**Viva:-** u. Pre Lab (2.5)	5	
	v. Post Lab(2.5)		

Pre-Lab Questions

Simulation of Boost Converter using MATLAB

14. What are the advantages of simulation?

15. Define duty cycle.

16. What is the major difference between buck and a boost converter?

17. What are the different types of chopper?

18. Discuss the different control strategies used for choppers.

Expt.No.11 Simulation of Boost Converter using MATLAB

Aim

To simulate a boost converter and obtain the suitable waveforms using MATLAB /Simulink

Apparatus Required

1. A PC with MATLAB Software

Theory

A Boost converter is a DC to DC converter in which the output voltage is greater than the input voltage. It is also called as step up converter. The name step up converter comes from the fact that analogous to step up transformer the input voltage is stepped up to a level greater than the input voltage.

The main working principle of boost converter is that the inductor in the input circuit resists sudden variations in input current. When switch is OFF the inductor stores energy in the form of magnetic energy and discharges it when switch is closed. The capacitor in the output circuit is assumed large enough that the time constant of RC circuit in the output stage is high. The large time constant compared to switching period ensures a constant output voltage of $V_o(t) = V_o$ (constant). The switch can be a MOSFET/IGBT.

The output voltage can be varied depending on the duty cycle of the switch which is given by the expression

$$V_0 = V * \frac{1}{1-D}$$

Circuit Diagram

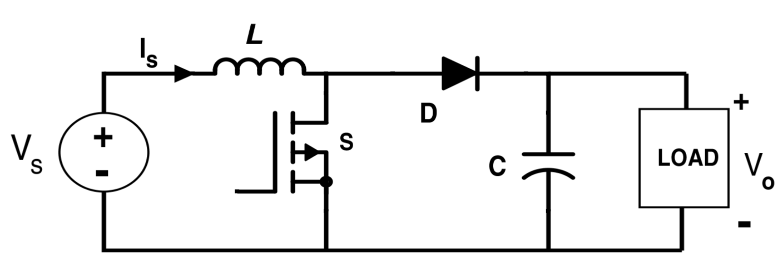

Fig 1 Circuit Diagram of a boost converter

Procedure

1. In MATLAB software open a new model in File->New->model.
2. Start SIMULINK library browser by clicking the symbol in toolbar
3. And open the libraries that contain the blocks you need. These usually will include the sources, sinks, math and continuous function block and possibly other.
4. Drag the needed blocks from the library folders to that new untitled simulink window. You must give it a name using the Save as menu command under the File menu heading. The assigned filename is automatically appended with an .mdl extension.
5. Arrange these blocks in orderly way corresponding by MATLAB model shown below.
6. Interconnect the blocks by dragging the cursor from the output of one block to the input of another block.
7. Double click on any block having parameters that must be established and set these parameters.
8. It is necessary to specify a stop time for the simulation; this is done by clicking on the simulation parameters entry on the simulation-> parameters entry on the simulation toolbar.
9. Now we are ready to simulate the block diagram. Press start icon to start the simulation. After simulation is done, double click the scope block to display the output. Click the auto scale icon in the display window to scale the axis as per variable range.
10. Finally Save the output

Tabular Column

Set DC Input Parameter (Say Amplitude =12 V); Set Inductor Parameter (Inductance=0.1 H); Set Pulse generator Parameter (Period=10e-6 sec, Pulse width=50%(duty cycle) and Phase delay= 0sec

S.No	Duty Cycle	Theoretical output voltage	Simulated output voltage
1	0.4		
2	0.5		
3	0.6		
4	0.7		
5	0.8		

Model Waveform

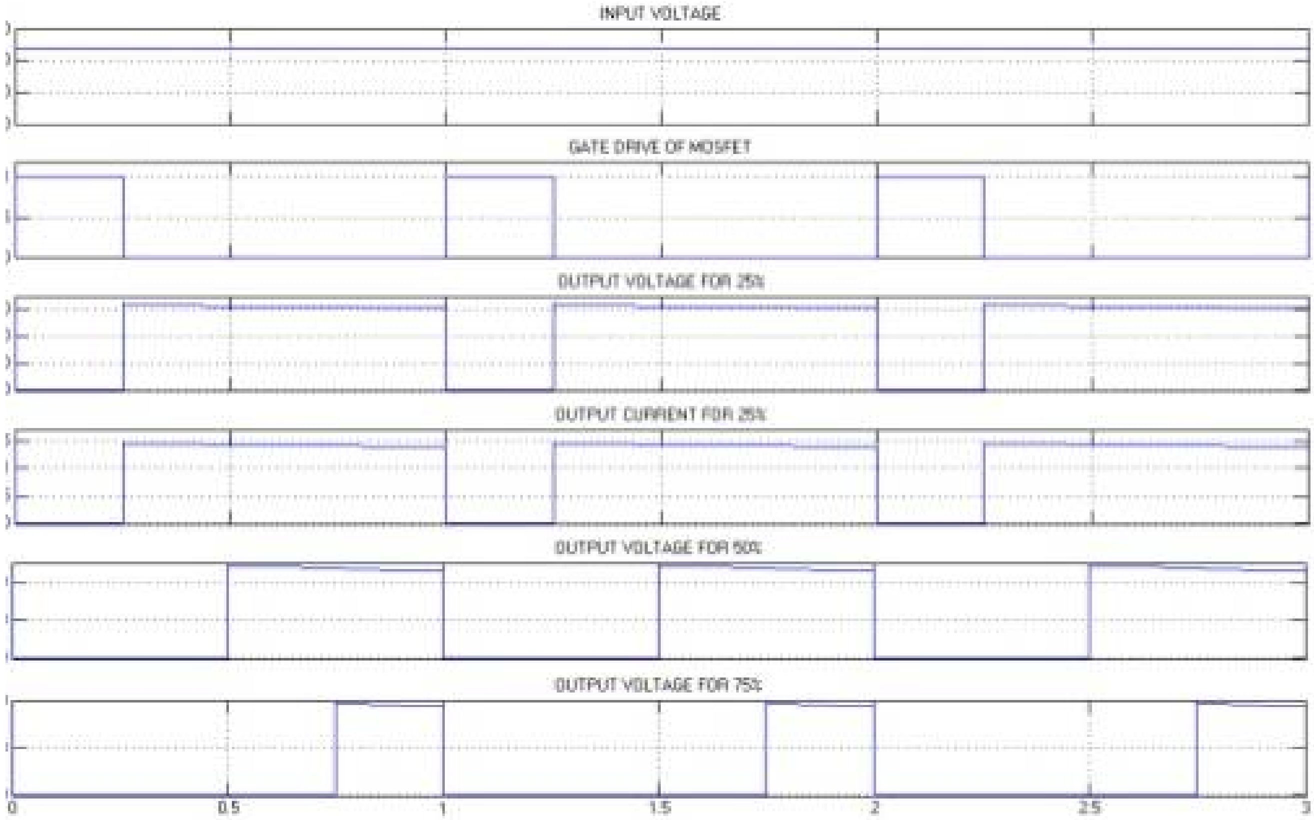

Fig 2Output Voltage and Current waveforms for different duty cycles in a boost converter

Result

Thus the boost operation of a converter is simulated and verified with the theoretical value.

Post lab questions

Simulation of Boost Converter using MATLAB

13. Why thyristors are not preferred for a chopper circuit?

14. For an input voltage of 24 V and duty cycle of 75%, calculate the output voltage.

15. What are the applications of Boost converter?

16. Explain why frequency modulation is not preferred.