POWER ELECTRONICS LABORATORY REPORT

Note:

Before going for connections, please read the datasheet of components used in the circuit.

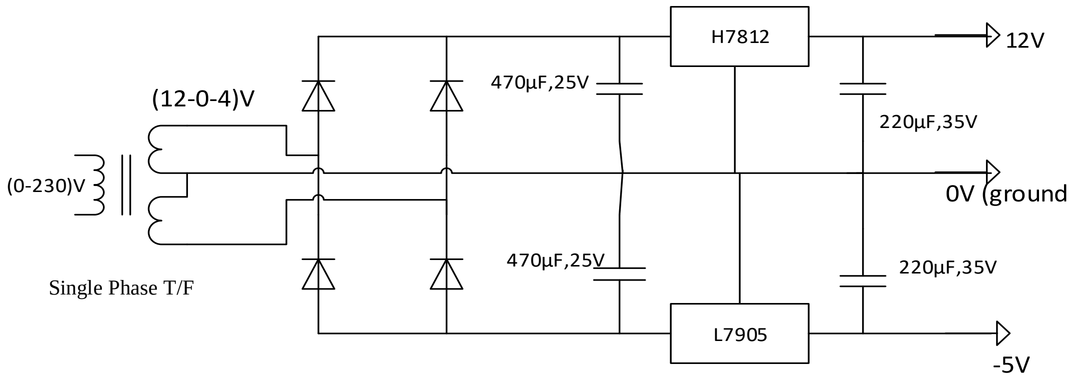
Contents: ***Pg.No.***

Experiment-1

Voltage Regulation Circuit

i) ***Aim***: To generate regulated voltage levels of **'12V'** and **'-5V'** in order to provide as gate triggering levels for MOSFET in switching application.

ii) ***Circuit diagram***:

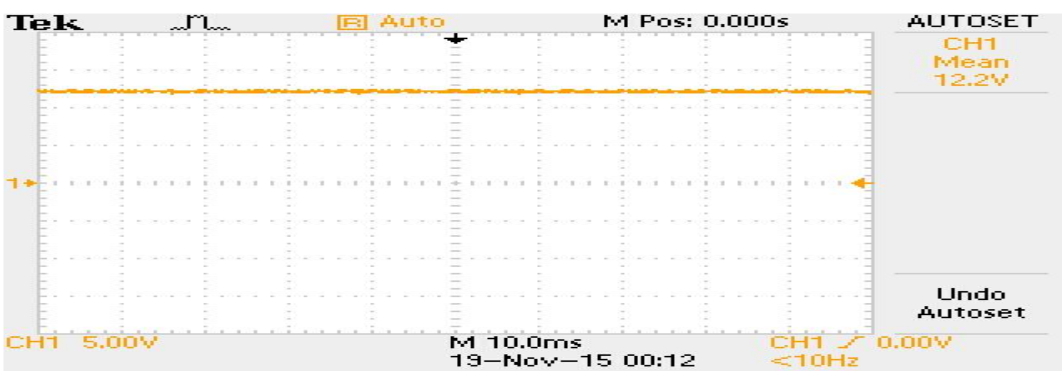


iii) ***Components:***

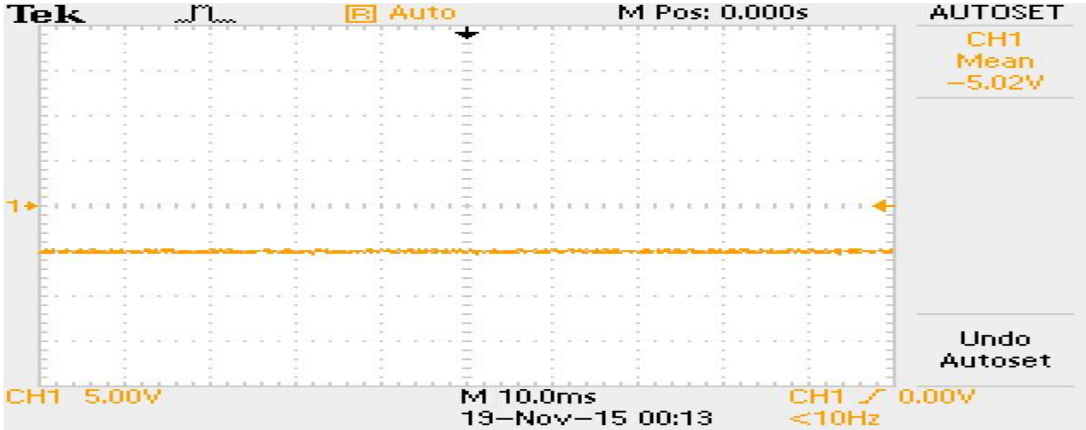
S.No.	Component name	Rating	Quantity
1.	Capacitor	470µF,25V	2
2.	Capacitor	220µF,35V	2
3.	PN-junction diode	IN 4007	4
4.	Single phase transformer	(0-230)/(12-0-4)	1
5.	Positive voltage regulator	IC H7812	1
6.	Negative voltage regulator	IC L7905	1

iv) ***Results***:

a) Voltage waveform observed between the output terminal of IC H7812 (Positive voltage regulator) and ground terminal of Single phase transformer is



b) Voltage waveform observed between the output terminal of IC 7905 (Negative voltage regulator) and ground terminal of Single phase transformer is as



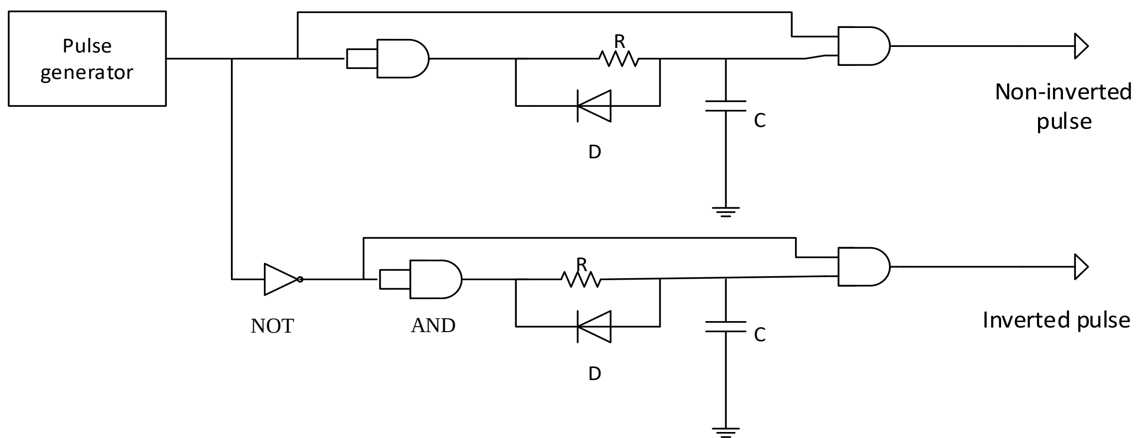
Experiment-2

Dead band circuit and Gate Driver Circuit

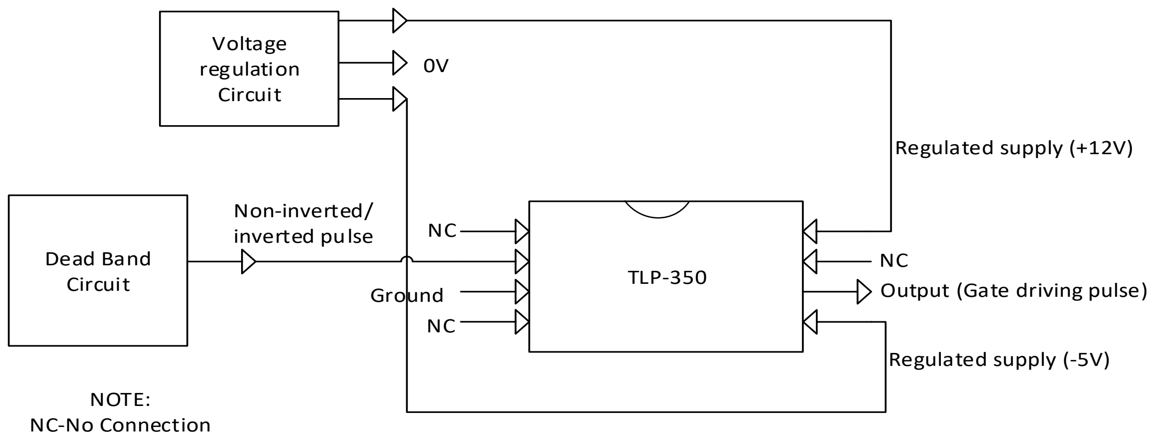
i) ***Aim***: To design the Dead band circuit and Gate driver circuit for MOSFET.

ii) ***Circuit diagram***:

a) Dead band circuit: To provide delay in generated pulses of gate driver circuit.



b) Gate Driver Circuit: Generates pulse to drive MOSFET



iii) ***Formulas & Calculations:***

V_{th} (Logic gate) = V_{pulse} (High level) x $(1-e^{(-t/RC)})$

Let t_{delay} =2.50 µs (typical value) ➔ RC =$3.82\text{x}10^{-6}$

Selected R =390 Ω and C= 10nF

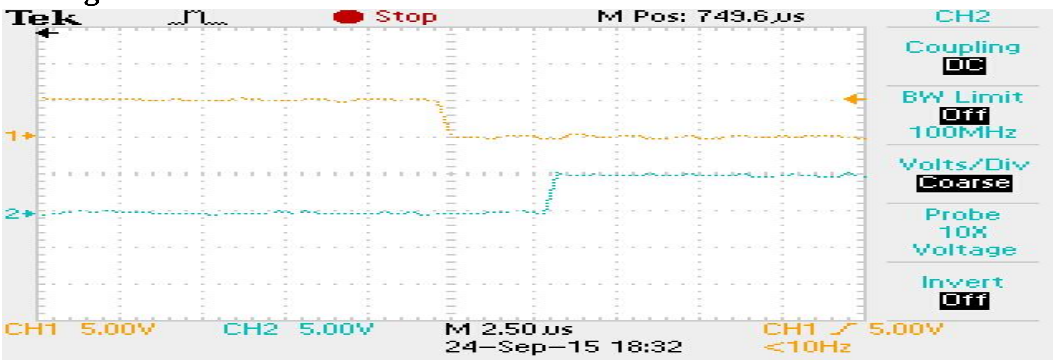
iv) ***Components*:**

S.No.	Component	Rating	Quantity
1.	AND gate	IC 7408	1
2.	NOT gate	IC 7404	1
3.	Resistor	380 Ω	2
4.	Capacitor	10 nF,100 V	2
5.	PN junction diode	IN 4007	2
6.	Gate driver	TLP 350	1
7.	Pulse generator		1

v) **Results:**

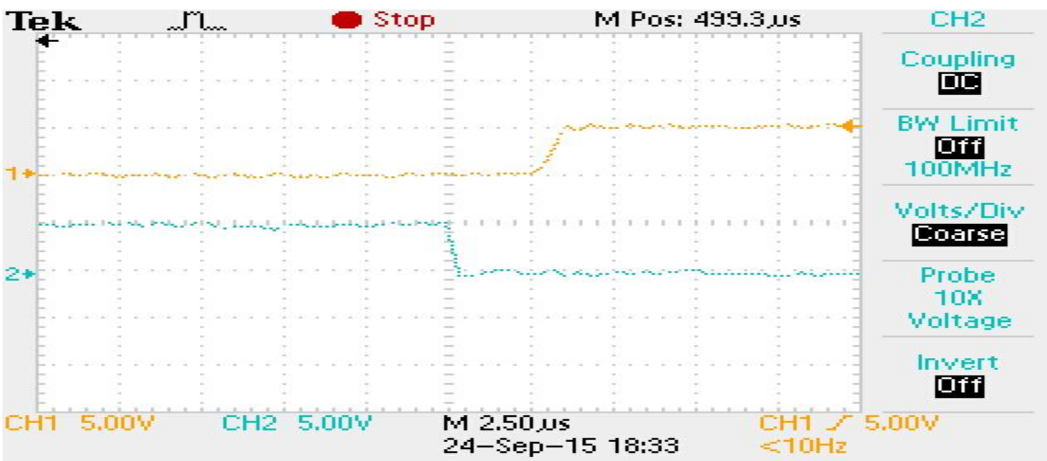
a) Dead band circuit:

During OFF time



Off-time dead band observed =2.50µs (approximately)

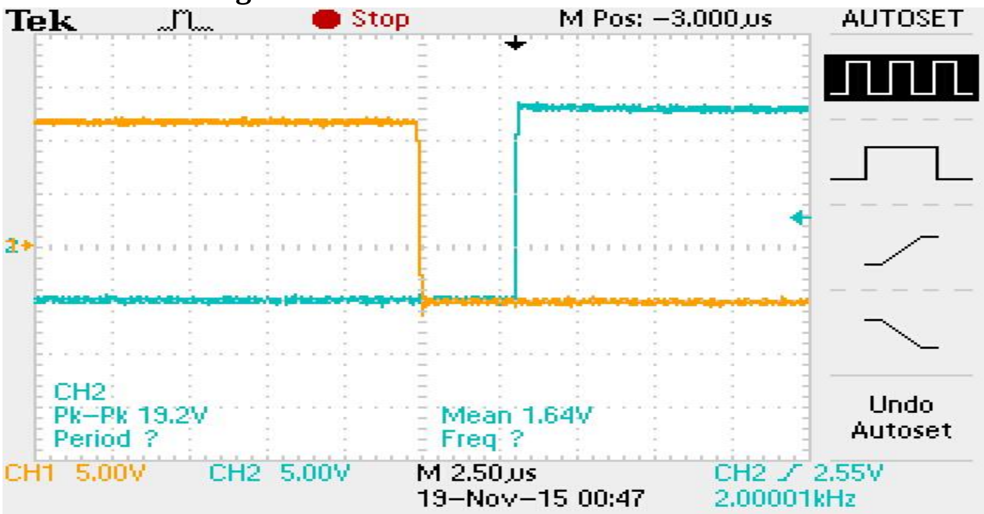
During ON time



On-time dead band =2.50µs (approximately)

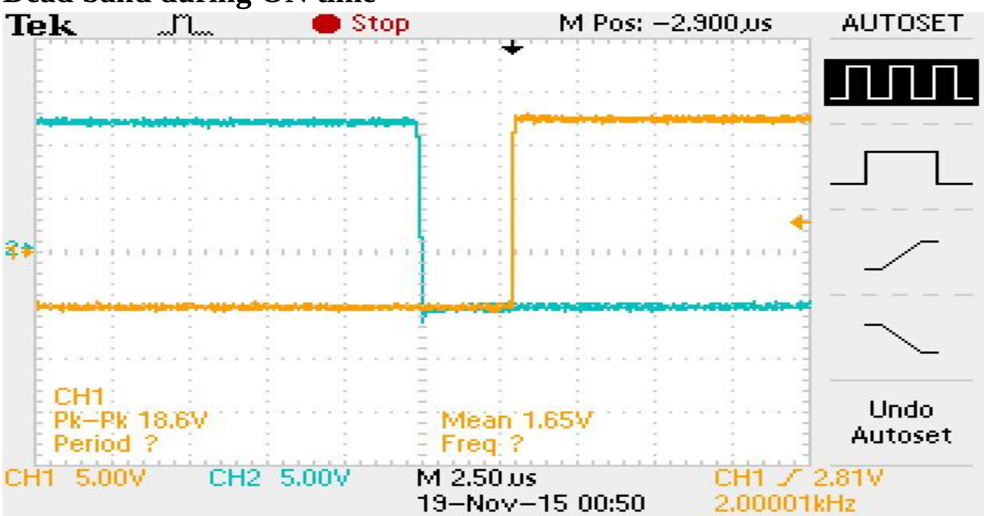
b) Gate driver circuit

Dead band during OFF time



Pulse’s high level = +12V
Pulse’s low level = -5V
Off-time dead band for gate driving pulse = 2.50μs

Dead band during ON time



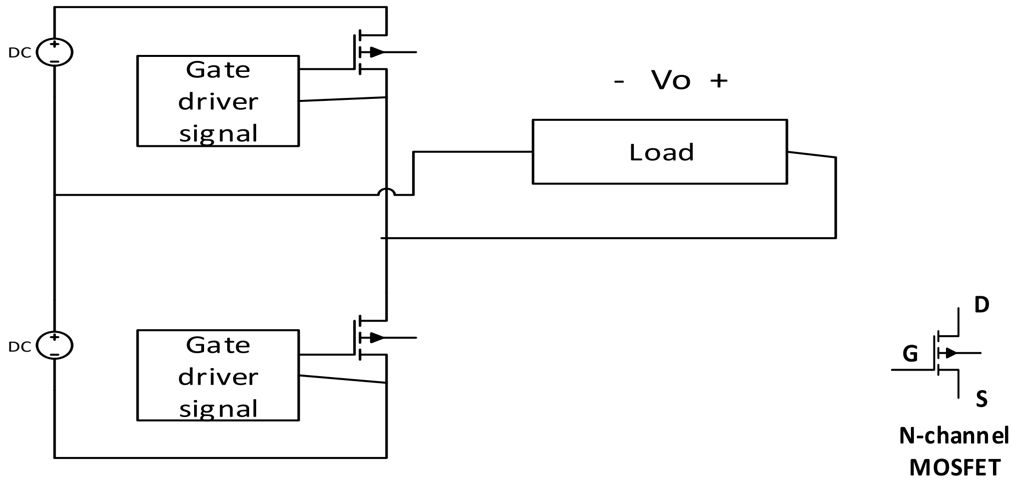
Pulse’s high level = +12V (approx.)
Pulse’s low level = -5V (approx.)
On-time dead band of gate driving pulse = 2.50μs (approx.)

Experiment-3

Single Phase Half-Bridge Inverter

i) ***Aim:*** To design a Single phase half-bridge inverter circuit using MOSFETs as switches.

ii) ***Circuit diagram:***

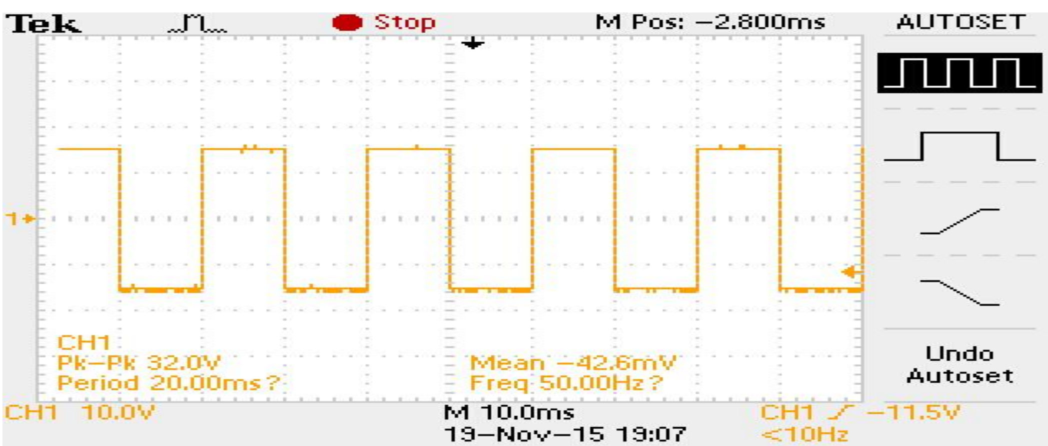


iii) ***Components datasheet:***

S.No.	Component	Rating	Quantity
1.	MOSFET	IRF 740	2
2.	Rheostat	(0-220)Ω/2.8A	1
3.	Regulated DC supply	±15 V, 3 A	1

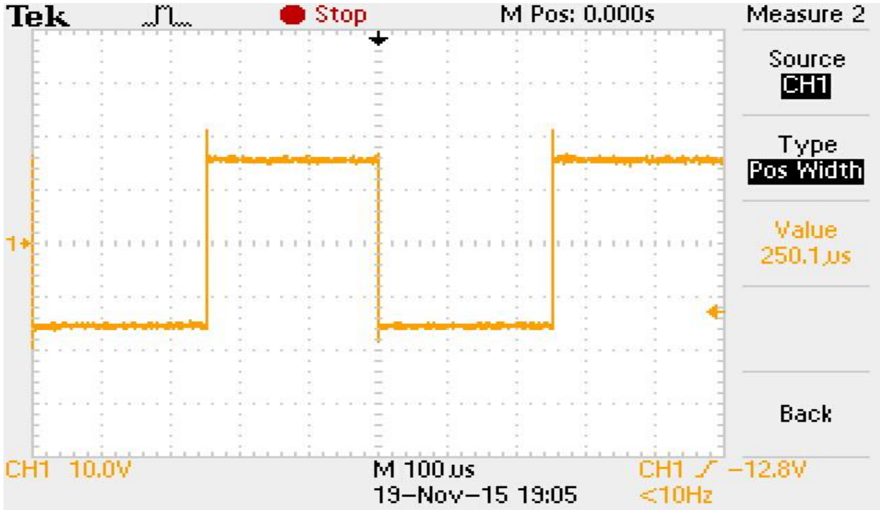
iv) ***Results:*** V_{DC} = 15V (approx.)

***a)* For frequency = 50 Hz**



Peak- peak value of above waveform =32V (approx.)

b) **For frequency = 2 kHz**



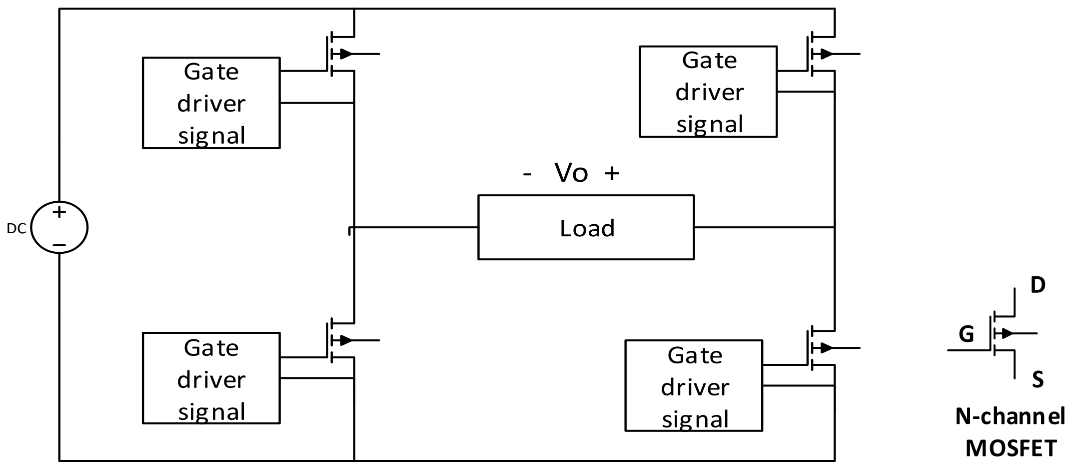
Peak-peak value of above waveform = 32 V (approx.)

Experiment-4

Single Phase Full Bridge Inverter

i) ***Aim:*** To design a Full-bridge inverter circuit using MOSFETs as switches.

ii) ***Circuit diagram:***

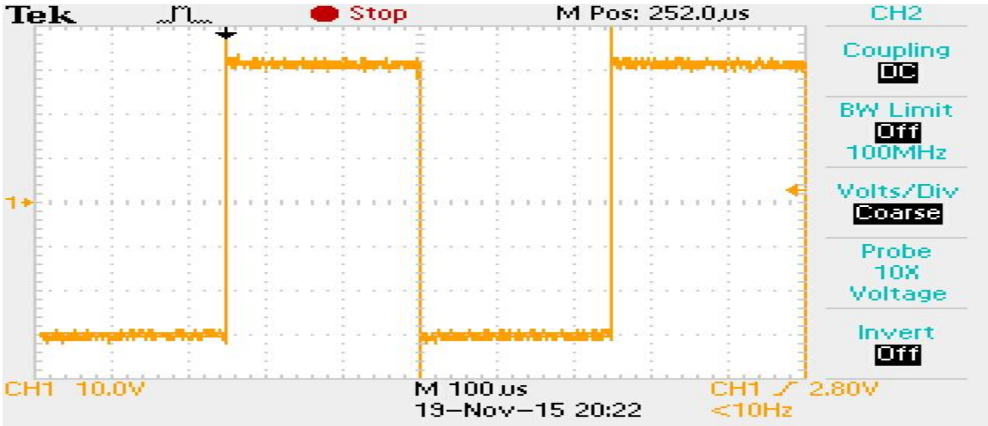


iii) ***Components datasheet:***

S.No.	Component	Rating	Quantity
1.	MOSFET	IRF740	4
2.	Rheostat	(0-220)Ω/2.8A	1
3.	Inductor	2mH	1
4.	Regulated DC supply	±15 V, 3 A	1

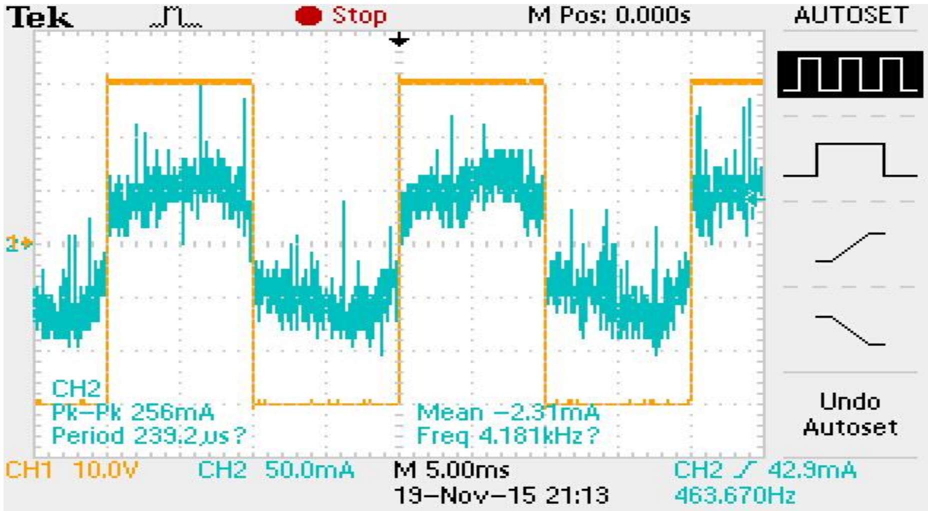
iv) ***Output waveforms & Results:***

a) Voltage between the pole points when there is no load



Positive peak =30V (approx.); Negative peak = 30V (approx.) and frequency=2 kHz

b) When load is R=220Ω and L=2mH, The voltage across load and current through load



Voltage positive peak= 30V, negative peak = 30V and frequency =50Hz

Experiment-5

Buck Converter

i) ***Aim:*** Designing of buck converter as per the specified requirements given below

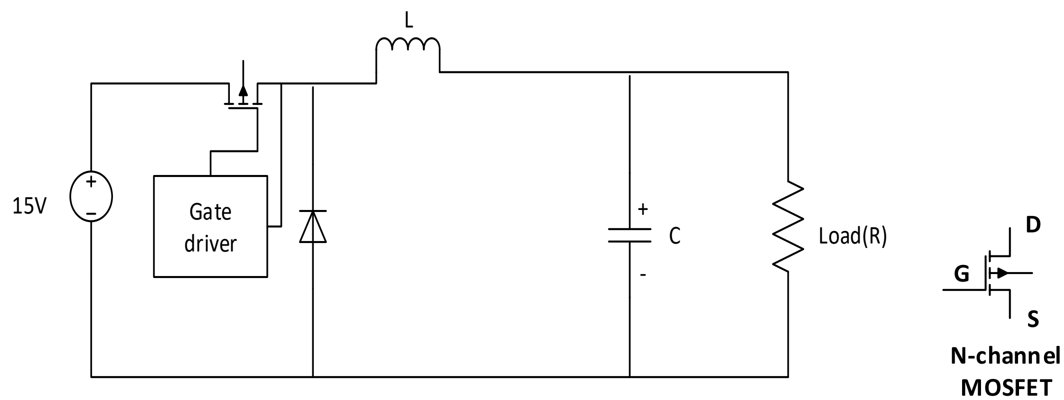
Input voltage, V_{in} = 15V

Output voltage, V_{out}=6V

Ripple current, Δi_L = 11% of I_{Load}

Ripple voltage, ΔV_{out} = 6% of V_{out}

ii) ***Circuit diagram:***



iii) ***Formulas & Calculations:***

$$L = \frac{V_{out}(1-D)}{\Delta i_L * f_s} \text{ H}$$

$$C = \frac{\Delta i_L}{8*\Delta V_{out}*f_s} \text{ F}$$

$$D = \frac{V_{out}}{V_{in}}$$

Calculations:

Let R_{Load} =13 Ω; switching frequency f_s =36 kHz

D=0.4

I_{Load} =V_{out}/R_{Load} =0.4615A ;

Δi_L =11% of I_{Load} ;

L=2mH;

ΔV_{out}=0.36 V;

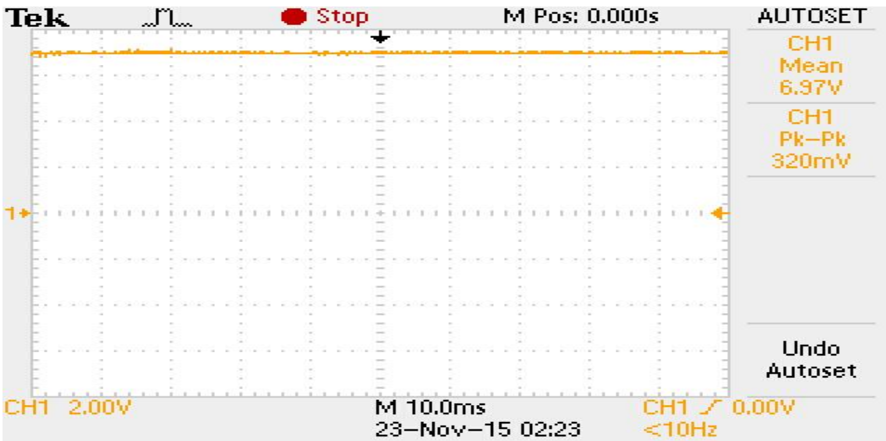
Selected L =2mH; C=(2.2+470)µF

iv) *Components:*

S.No.	Component	Rating	Quantity
1.	MOSFET	IRF740	2
2.	Inductor	2mH	1
3.	Capacitor	472.2µF	1+1
4.	Rheostat	(0-220)Ω/2.8A	1
5.	Regulated DC supply	±15 V, 3 A	1

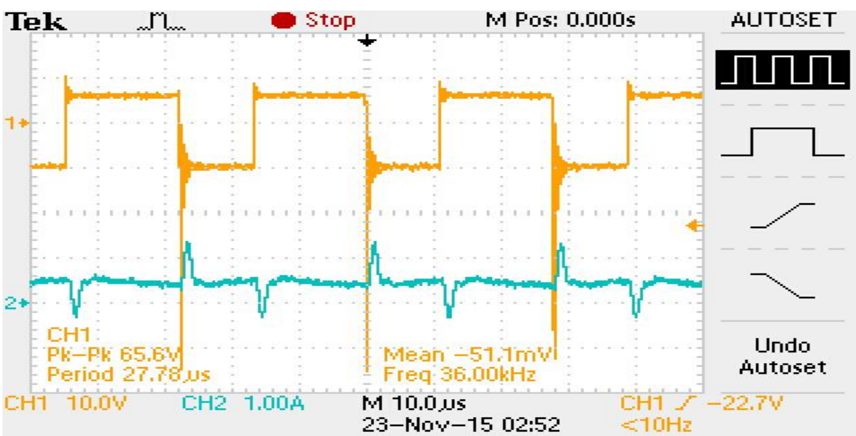
v) *Results:*

a) Output voltage across load (rheostat)



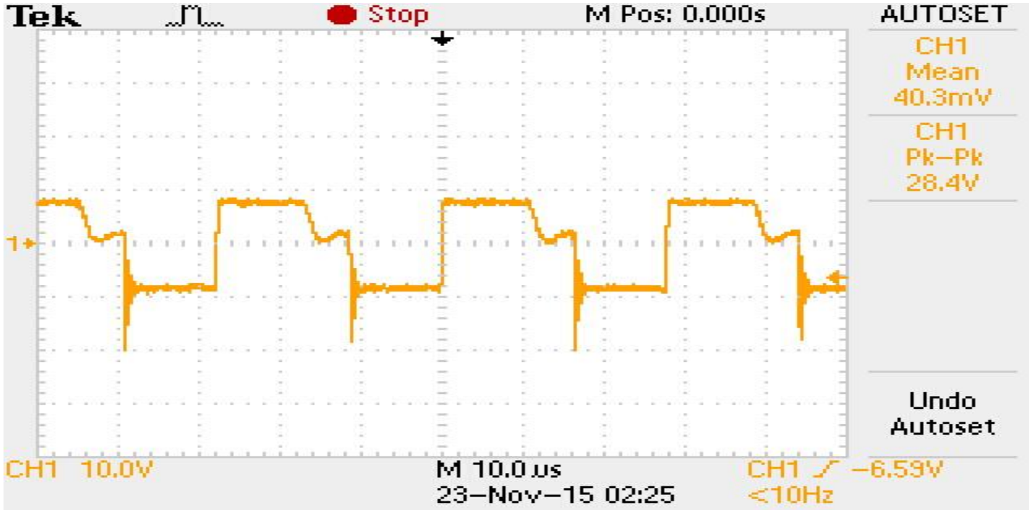
Mean value of voltage across load = 6.97 V
And ripple voltage=320mV=0.32V

b) Voltage across inductor and current through inductor waveforms



Observation: The surges in voltages waveforms during switching are due to values of Inductance and Capacitance present in the circuit.

c) Voltage across Inductor



Observation: The mean value of Voltage across Inductor over a period is observed as 40.3mV (Nearly zero) which represents the Voltage-sec balance and the deviation is due to disturbances.

Experiment-6

Boost Converter

i) ***Aim:*** Designing of boost converter as per the specified requirements given below

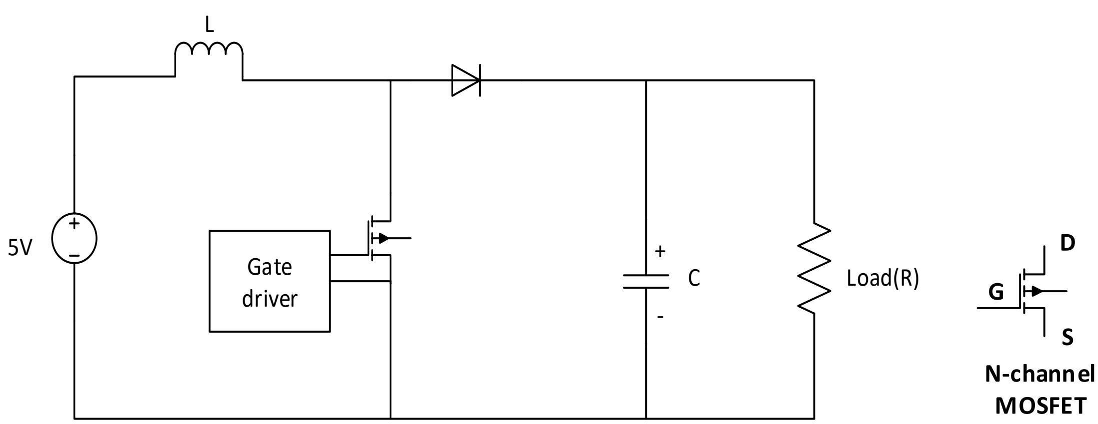
Input voltage V_{in} = 10 V

Output Voltage V_{out}=25V

%current ripple, Δi_L = 5% of I_{Load}

% voltage ripple, ΔV_{out} = 7% of V_{out}

i) ***Circuit diagram:***



ii) ***Formulas & Calculations:***

Duty ratio, $\boldsymbol{D = 1 - \frac{V_{in}}{V_{out}}}$

$Inductance, \boldsymbol{L = V_{in} * \frac{D}{\Delta i_L * f_s}}$

$Capacitance, \boldsymbol{C = I_{out}/(\Delta V_{out} * f_s)}$

Calculations:

Let R_{Load}=16Ω;

V_{in}=10.4V;

D=60%;

F_s=36 kHz;

Select L=2mH; C= (470+2.2)µF

For selected C, ΔV_{out} =0.3%

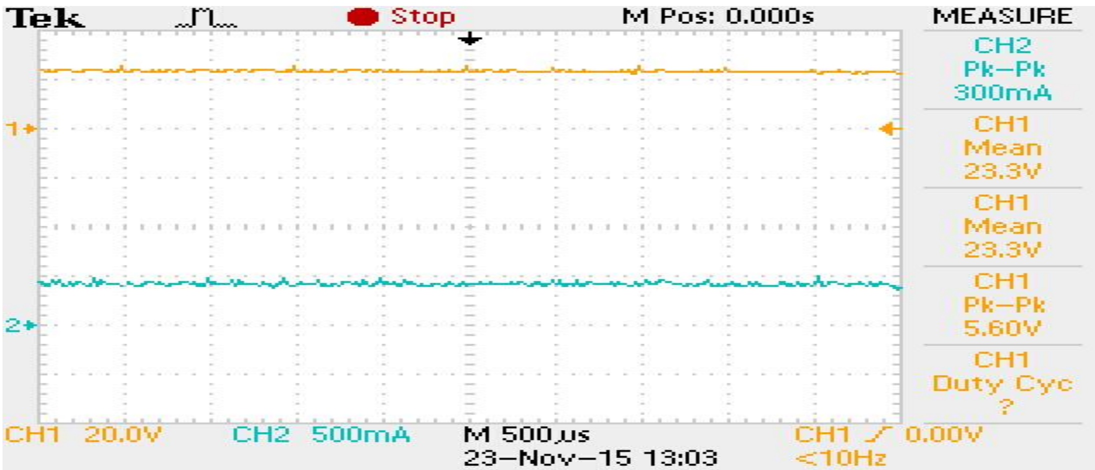
iii) Components:

S.No.	Component	Rating	Quantity
1.	MOSFET	IRF740	2
2.	Inductor	2mH	1
3.	Capacitor	(470+2.2)µF	1
4.	Rheostat	220Ω /2.8A	1
5.	Regulated DC supply	±15 V, 3 A	1

iv) Results:

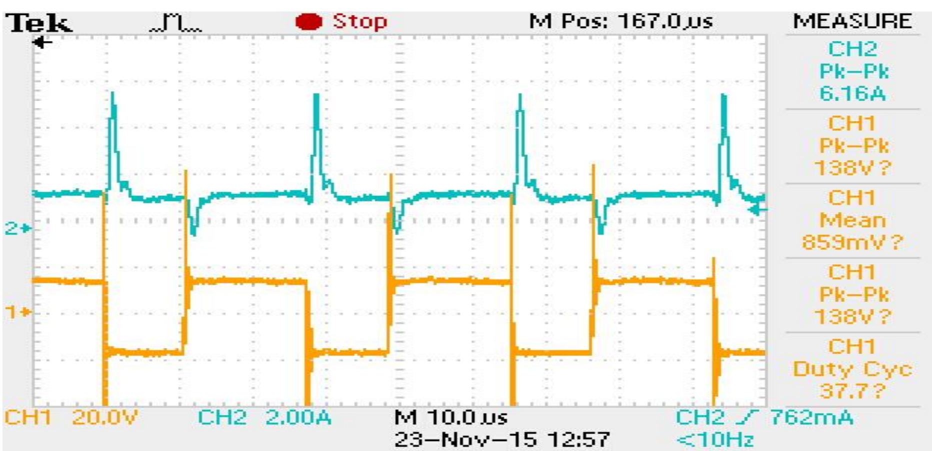
a) For Frequency, f_s=36kHz:

Voltage across load:



Voltage across load is observed as **23.3V.**

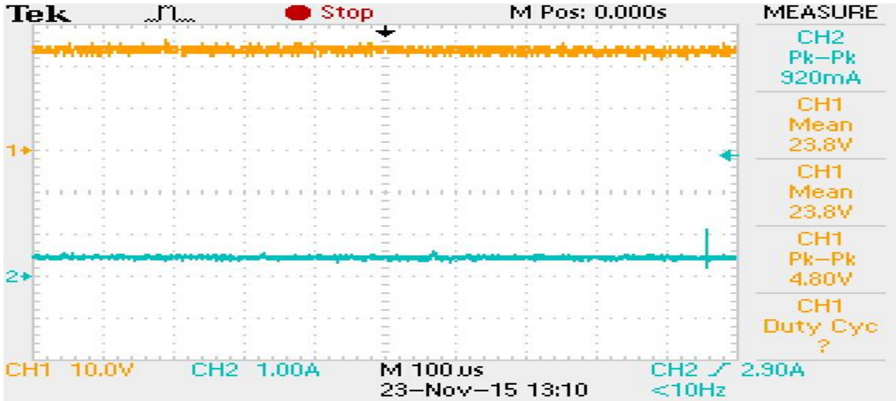
Current through Inductor and Voltage across inductor:



Observation: From above waveform, Mean value of voltage across inductor over a period is **859mV** (which is close to zero), implies **volt-sec** balance across inductor over a period. This difference is mainly due to switching surges.

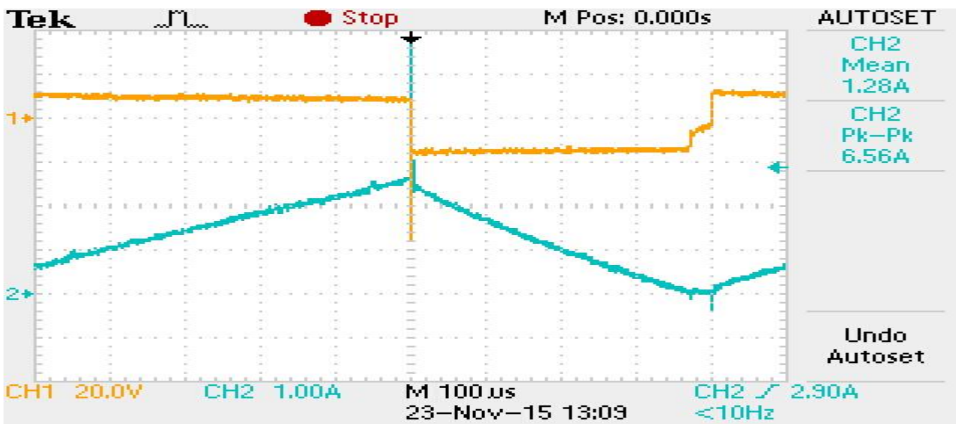
b) For Frequency, f_s=1 kHz:

Voltage across load:



Observation: voltage across load=23.8V

Voltage across inductor and Current through Inductor:



Observations: We can observe the zero current through inductor for a short duration of time, representing the discontinuous mode of operation.