Electrical Machines and Power Electronics Lab Report -5

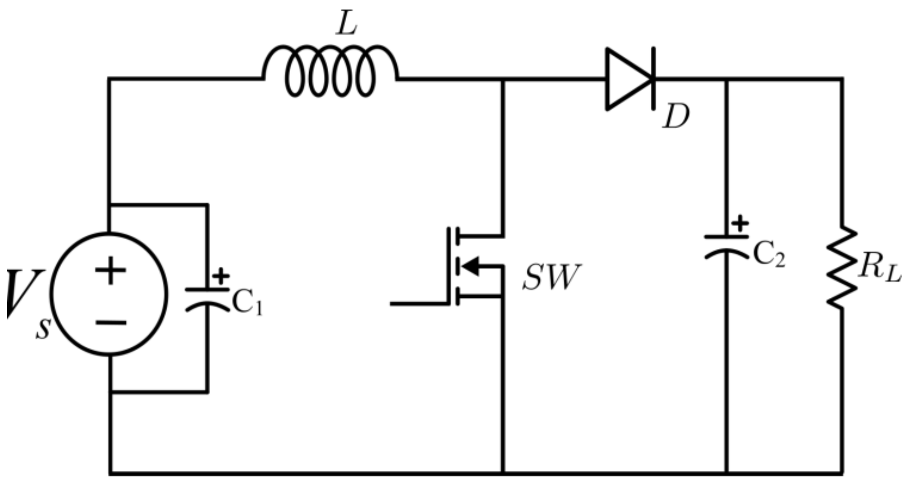
Experiment Name: Design of Boost converter for the given specifications (Vout=20V).

Aim: To boost the voltage by changing the duty cycle of the MOSFET and taking less voltage as input.

Components Required:

1. TL494 PWM Control Circuit
2. Circuit of Uncontrolled Rectifier
3. IRF840 MOSFET
4. Rheostat(50Ω/5A)
5. Capacitor-input 470µF/25V
6. Capacitor-output 100µF/35V
7. Inductor
8. Diode(BY399)

Experiment setup:



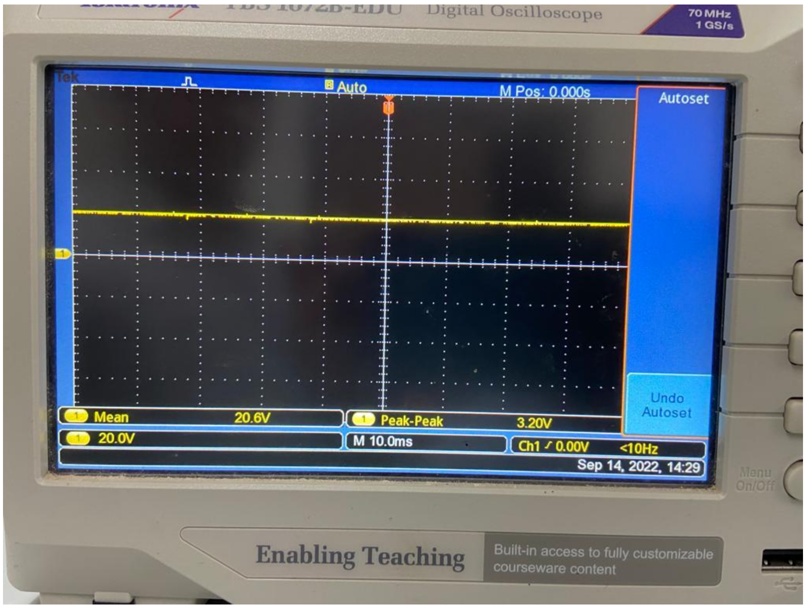
Procedure:

1. Connect the components according to the circuit diagram
2. Set up the input for the PWM generator using a transformer and a rectifier.
3. Apply the gate pulses using the TL494 PWM generator designed earlier. The PWM generator is set in emitter follower mode with a push-pull configuration
4. Adjust the duty cycle to set the output voltage to 20V by setting the duty cycle of PWM = 0.25.
5. Adjust the load to set the input current to 1.5A.
6. If the current increases more than 1.5A, even if you increased load to the max, try to decrease the duty cycle.

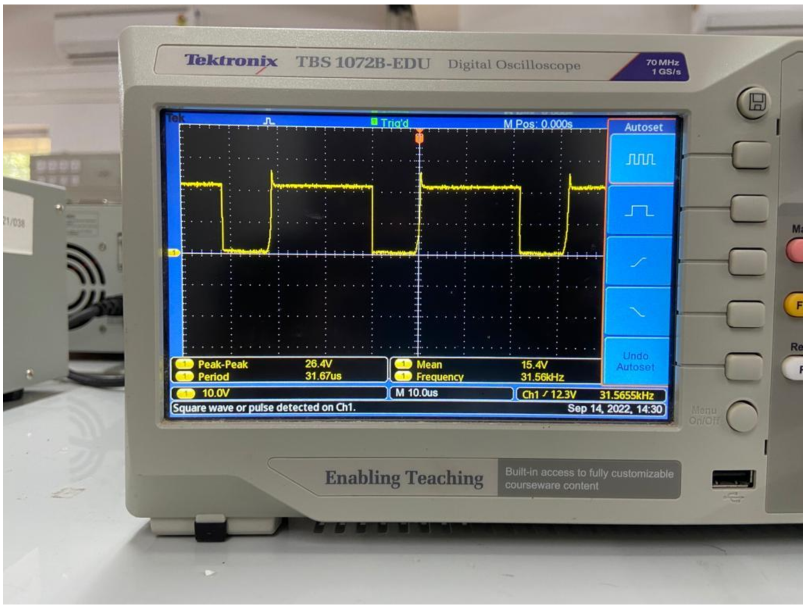
7. Obtain the waveforms of output voltage, MOSFET voltage, inductor voltage, and diode voltage.

Observations:

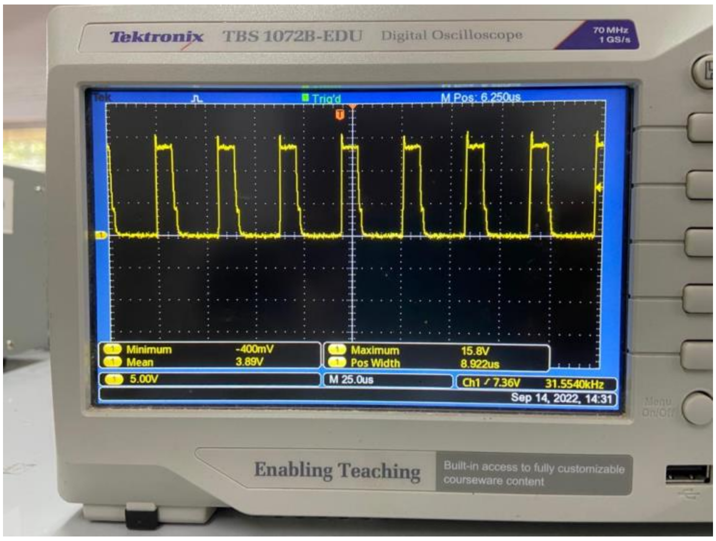
Output Voltage:



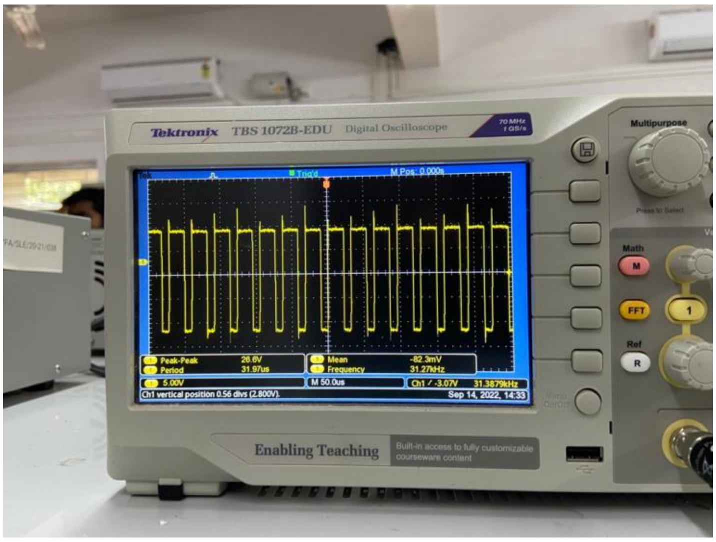
Mosfet Voltage:



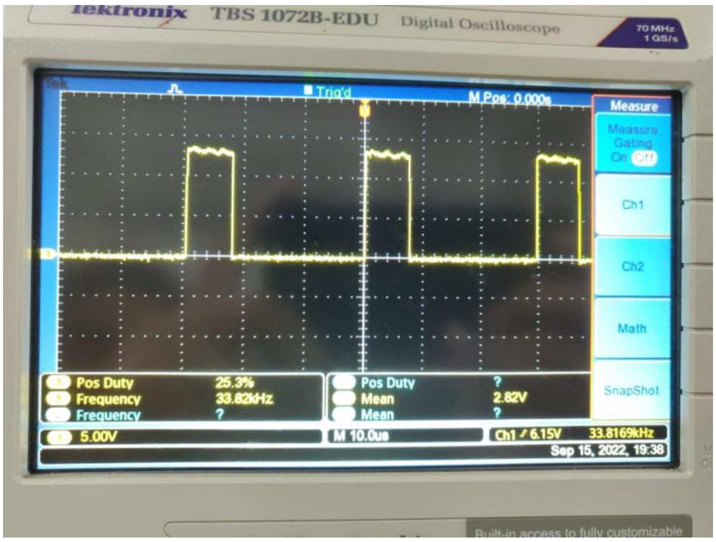
Diode Voltage:



Inductor Voltage:



PWM Generator:



* Boost convertor

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

d → duty cycle of mosfet

$$\frac{20}{15} = \frac{1}{d}$$

$d = 0.75$

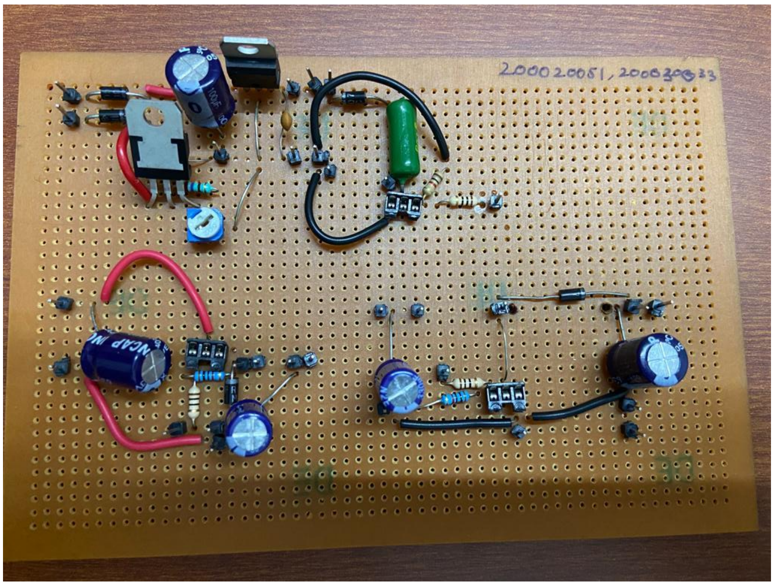
$d_{Mosfet} = 0.75$

$d_{PWM} = 1 - d_{Mos} = 0.25$

$d_{doide} = 1 - d_{mos} = 0.25$

Avg voltage of Inductor = 0 V

Soldered Board:



Additional Results:

1. Maximum switch current:

$d \rightarrow$ duty cycle

$\eta \rightarrow$ efficiency of converter

$V_{IN}(min) \rightarrow$ minimum input voltage

$V_{out} \rightarrow$ desired output voltage

$$d = 1 - \frac{V_I(min) \times \eta}{V_{out}} \quad -①$$

$$\Delta I_L = \frac{V_{IN}(min) \times d}{f_s \times L}$$

$f_s \rightarrow$ minimum switching frequency

$V_{in}(min) \rightarrow$ minimum input voltage

$L \rightarrow$ selected inductor value

$d \rightarrow$ duty cycle came in eq ①

$\Delta I_L \rightarrow$ inductor ripple current

$$I_{sw}(max) = \frac{\Delta I_L}{2} + \frac{I_{out}(max)}{1-D}$$

$I_{out}(max)$ = max current needed

2. Inductor selection:

$$L = \frac{V_{IN} \times (V_{OUT} - V_{in})}{\Delta I_L \times f_s \times V_{OUT}}$$

$V_{IN} \rightarrow$ input voltage

$V_{out} \rightarrow$ desired output voltage

$f_s \rightarrow$ minimum switching frequency

$\Delta I_L \rightarrow$ estimated inductor ripple.

$$\Delta I_L = (0.2 \text{ to } 0.4) \times I_{out}(max) \times \frac{V_{out}}{V_{in}}$$

Analysis:

1. Boost converter is a widely used application in our daily; it is used in automobiles, motors, etc.….
2. The buck converter is modeled using the MOSFET, and the Schottky diode(fast and to reduce the losses)led.
3. PWM generator makes the switching states in the circuit.
4. If the given load is small, a vast current will be drawn through the circuit, possibly burning up the MOSFET.
5. If you have more ripple in the PWM generator, you will get more ripple in the output voltage.
6. There is a chance of the circuit going into underdamped if the capacitor value is less, By increasing the value of capacitor will change the situation into overdamped.