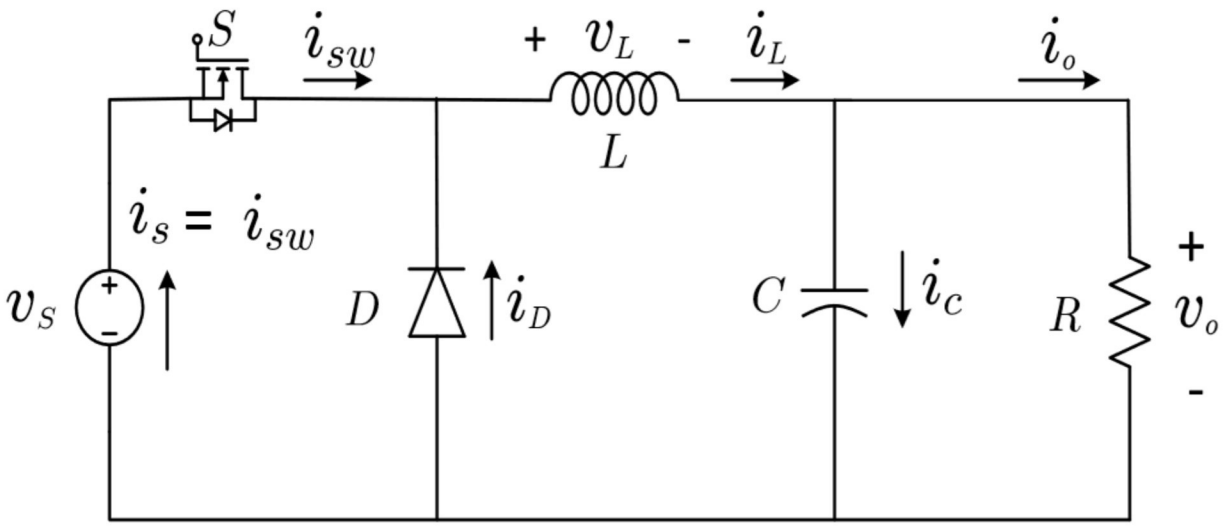
BUCK CONVERTER

Definition: Buck converter or stepdown converter is a converter which steps down the output voltage compared to input source voltage.

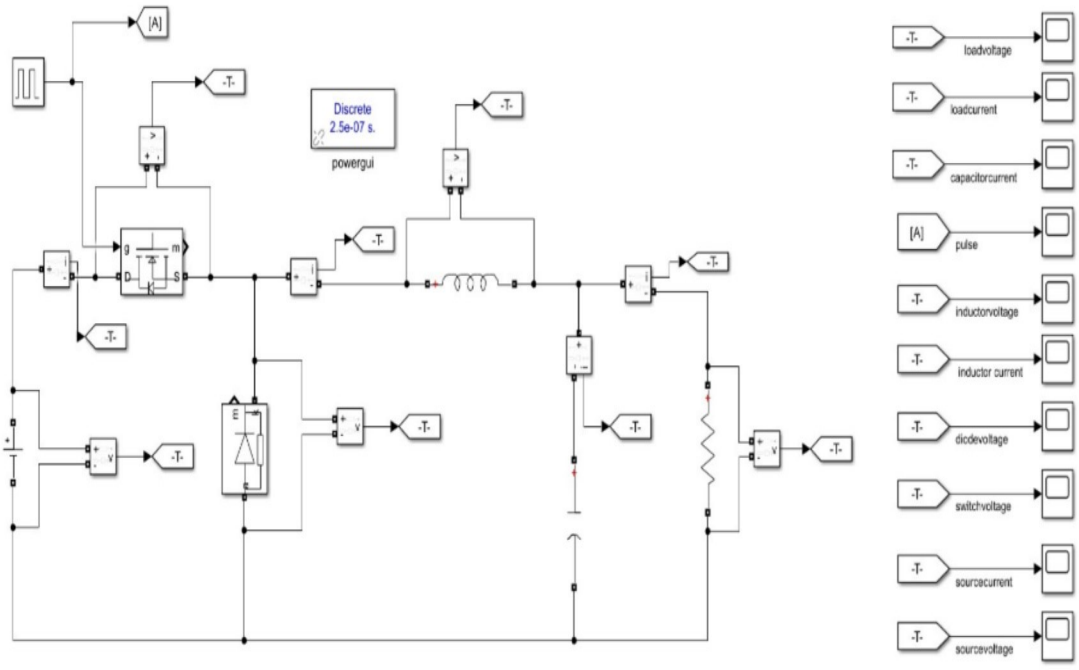
Circuit Diagram:



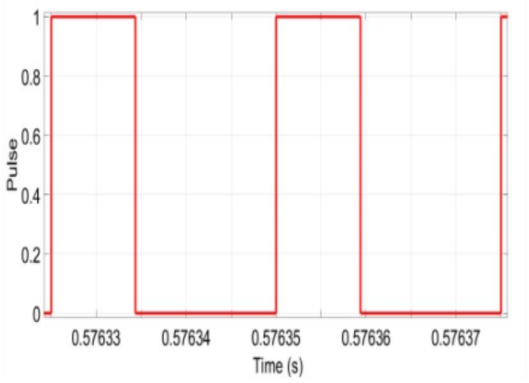
Designed Circuit Parameters:

Parameters	Values
Vs	48 V
D	0.375
L	97.5 μH
C	100 μF
R	10 Ω
Vo	18 V
f	40 KHz

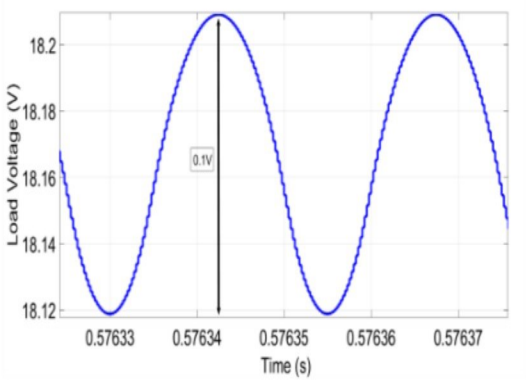
Simulated Circuit:



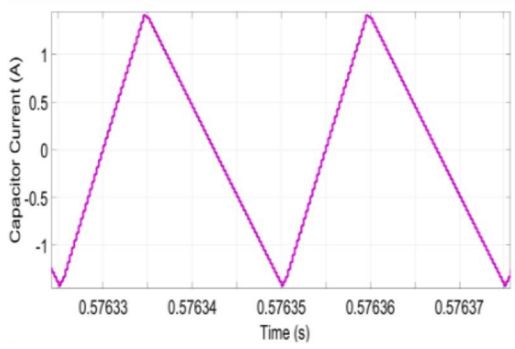
Simulated Output Results:



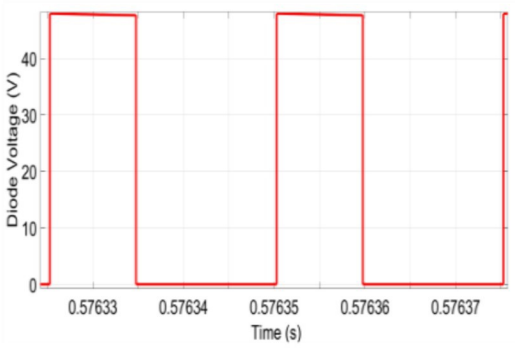
(a)



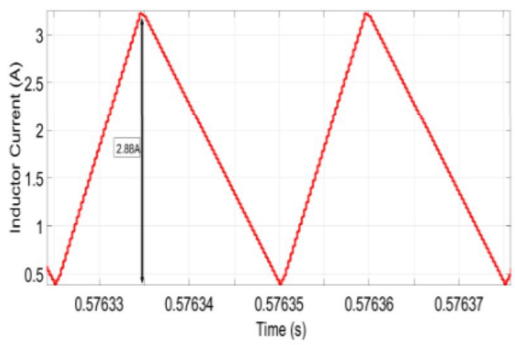
(b)


Capacitor Current (A)
1
0.5
0
-0.5
-1
0.57633
0.57634
0.57635
0.57636
0.57637
Time (s)

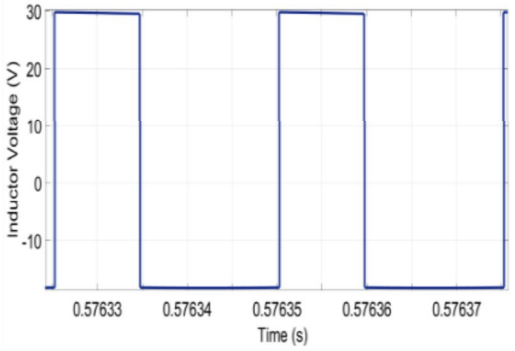
(c)


Diode Voltage (V)
40
30
20
10
0
0.57633
0.57634
0.57635
0.57636
0.57637
Time (s)

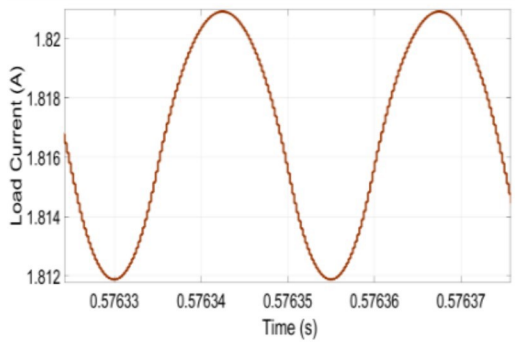
(d)


Inductor Current (A)
3
2.5
2
1.5
1
0.5
2.86A
0.57633
0.57634
0.57635
0.57636
0.57637
Time (s)

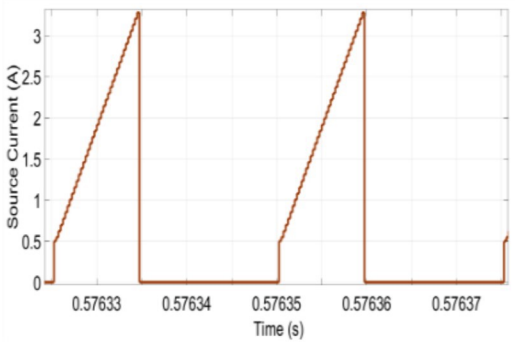
(e)


Inductor Voltage (V)
30
20
10
0
-10
0.57633
0.57634
0.57635
0.57636
0.57637
Time (s)

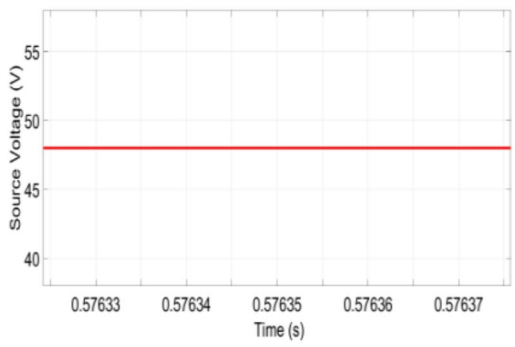
(f)


Load Current (A)
1.82
1.818
1.816
1.814
1.812
0.57633
0.57634
0.57635
0.57636
0.57637
Time (s)

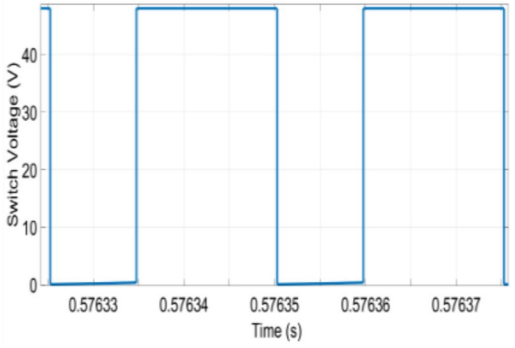
(g)


Source Current (A)
3
2.5
2
1.5
1
0.5
0
0.57633
0.57634
0.57635
0.57636
0.57637
Time (s)

(h)


Source Voltage (V)
55
50
45
40
0.57633
0.57634
0.57635
0.57636
0.57637
Time (s)

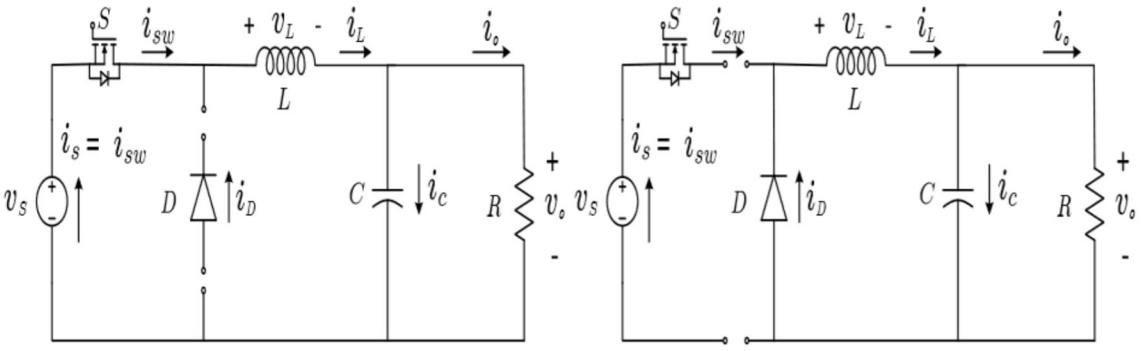
(i)


Switch Voltage (V)
40
30
20
10
0
0.57633
0.57634
0.57635
0.57636
0.57637
Time (s)

(j)

Figures (a) pulse (b) load voltage (c) capacitor current (d) diode voltage (e) inductor current (f) inductor voltage (g) load current (h) source current (i) source voltage (j) switch voltage

Operating Modes of a Buck Converter:



When S=1(On mode) When S=0(Off mode)

Under steady state

- **Volt-sec balance across inductor**

$$(V_s - V_o) * D * T_s = V_o * (1 - D) * T_s \tag{1}$$

$$V_s * D - V_o * D = V_o - V_o * D \tag{2}$$

$$\boxed{V_o = V_s * D}$$

- ## For L

$$-V_{in} + V_L + V_o = 0 \tag{3}$$

$$L * \frac{\triangle I}{DT} = V_{in} - V_o \tag{4}$$

Assumed $\triangle I = 2.88A$

$$L * \frac{2.8846 * 40k}{0.375} = 48 - 18 \tag{5}$$

$$\boxed{\text{L} = 97.5\ \mu\text{H}}$$

- **For C**

$$\frac{\triangle I * T_s}{8} = Q = c * (\triangle V) \tag{6}$$

Assumed $\triangle V = 0.09V$

$$C = \frac{2.8846}{40K * 8 * 0.09} \tag{7}$$

$$\boxed{\text{C} = 100\ \mu\text{F}}$$