Lab05: Software – Buck and Boost Converter

1.Buck Converter

Objective:

To study the operation and characteristics of a DC buck chopper by observing the current and voltage across the capacitor and inductor. To study the effect of varying the switching frequency and duty cycle on load current.

Procedure:

a) For buck converter, make the circuit shown in figure 1 in PSpice using the following parts:
   - VDC (voltage source)
   - VPULSE (voltage source)
   - IRF150 (Switch)
   - R (Resistance)
   - L (Inductance)
   - C (Capacitance)
   - DIN4002 (Diode)
   - GND_SIGNAL/CAPSYM
   - PARAM (Found in “special” library) (For defining variables and their values)

Double click on the parameter “PARAM” and then use “new column” or “new row” option for adding the variables and their values.

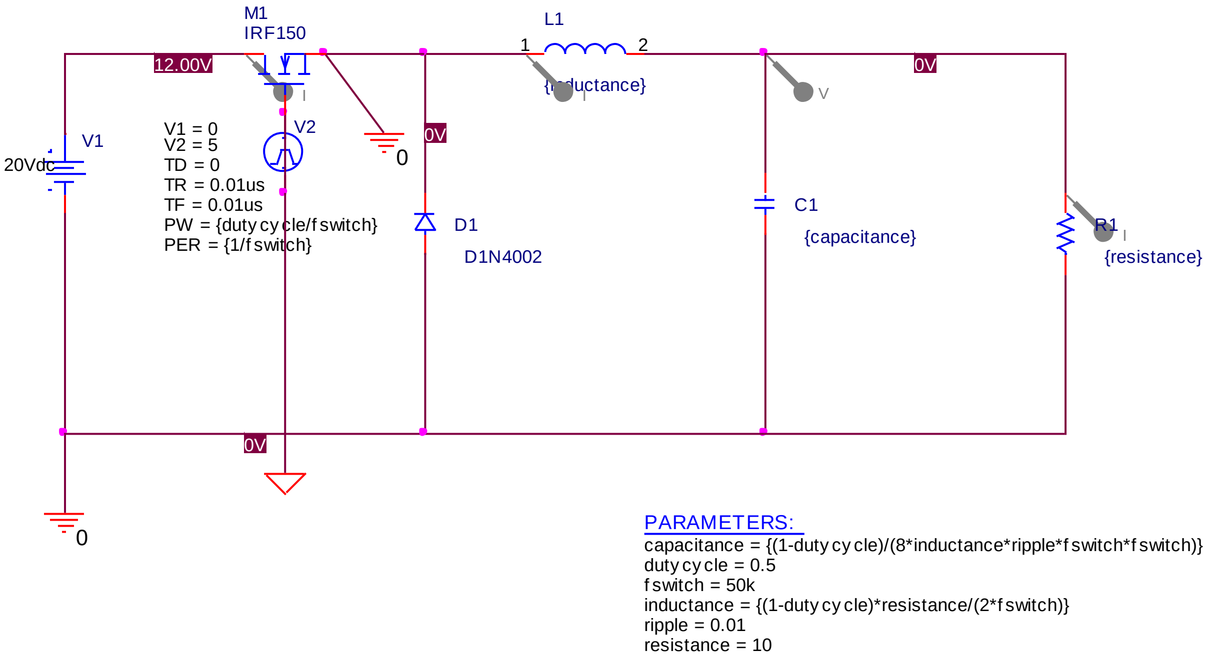
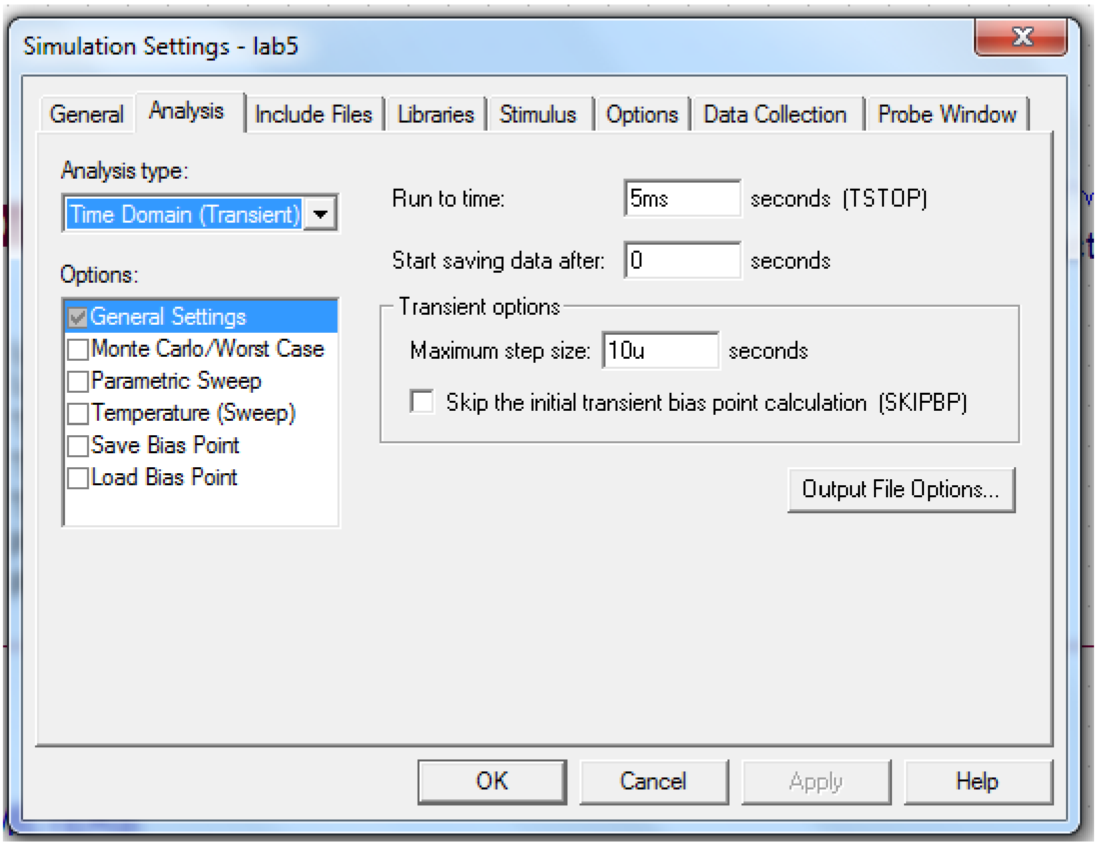
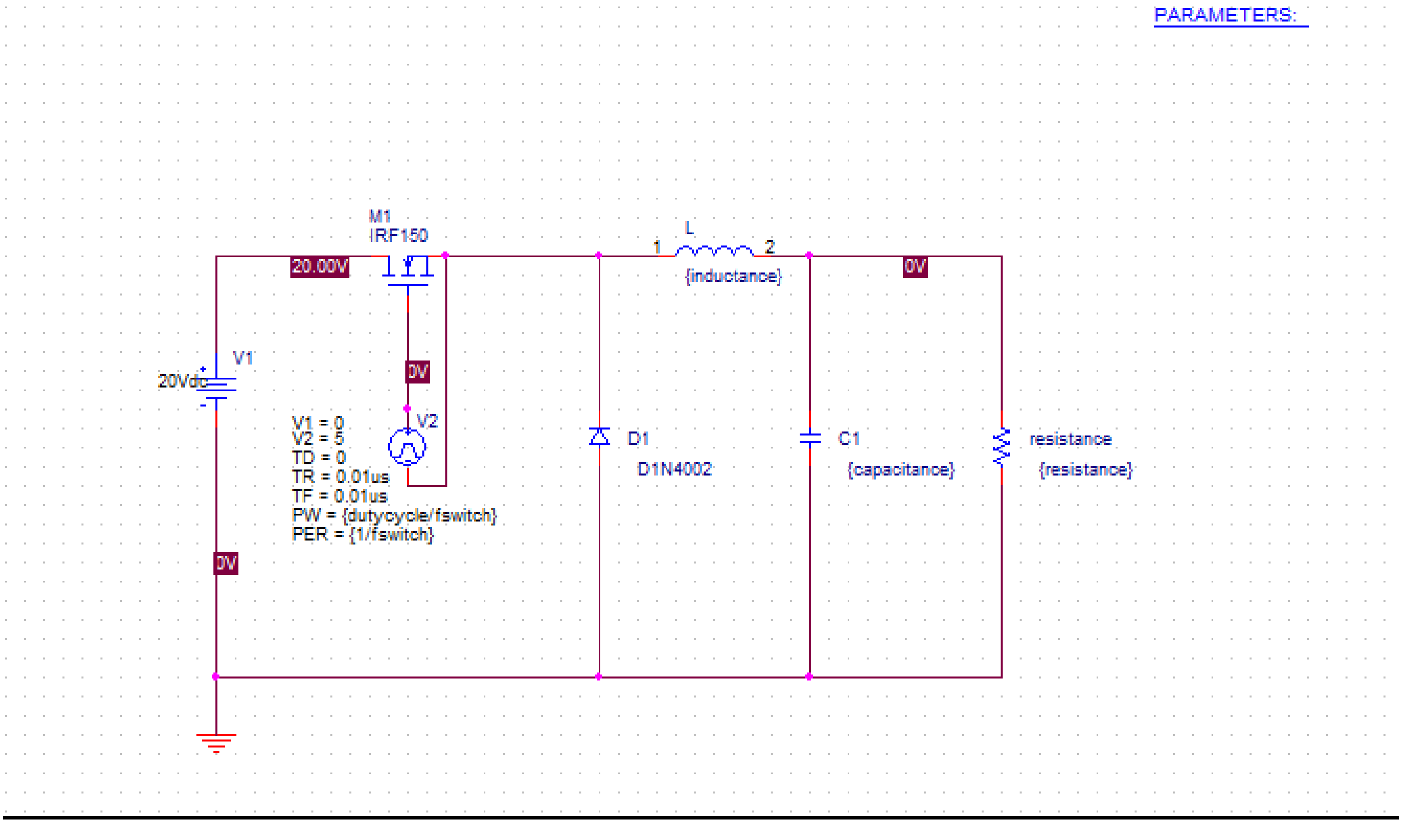


Figure 1(a). DC buck chopper

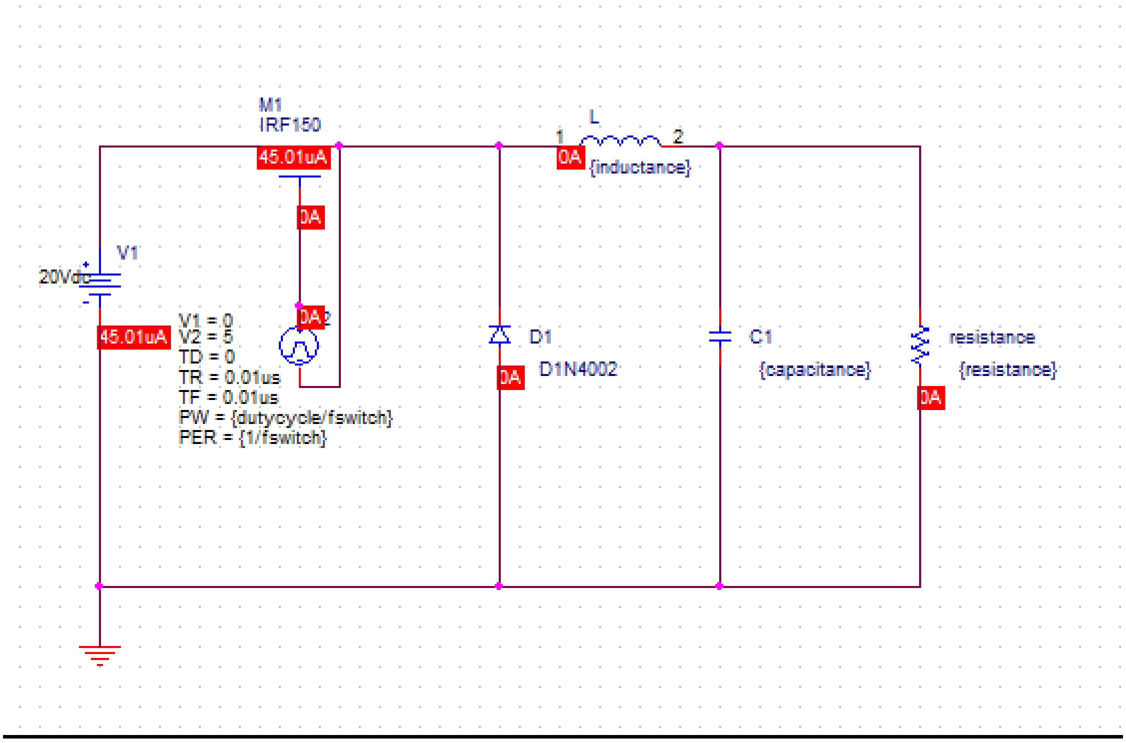
To perform transient analysis



Circuit:



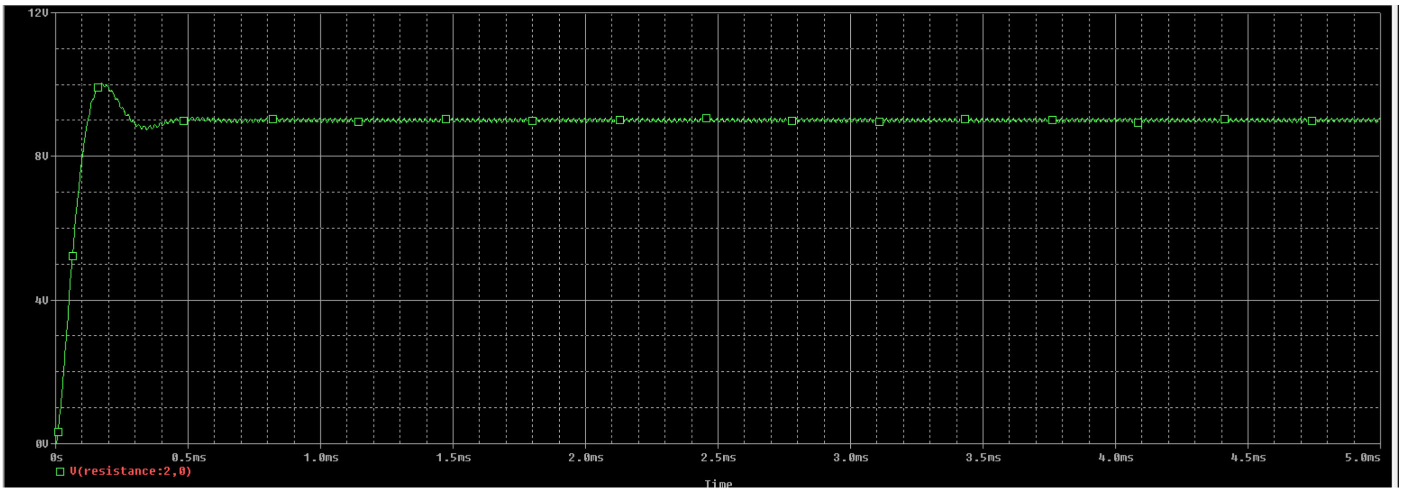
PARAMETERS:
M1
IRF150
20.00V
L
1
2
{inductance}
0V
V1
20Vdc
0V
V2
V1 = 0
V2 = 5
TD = 0
TR = 0.01us
TF = 0.01us
PW = {dutycycle/fswitch}
PER = {1/fswitch}
D1
D1N4002
C1
{capacitance}
resistance
{resistance}
0V



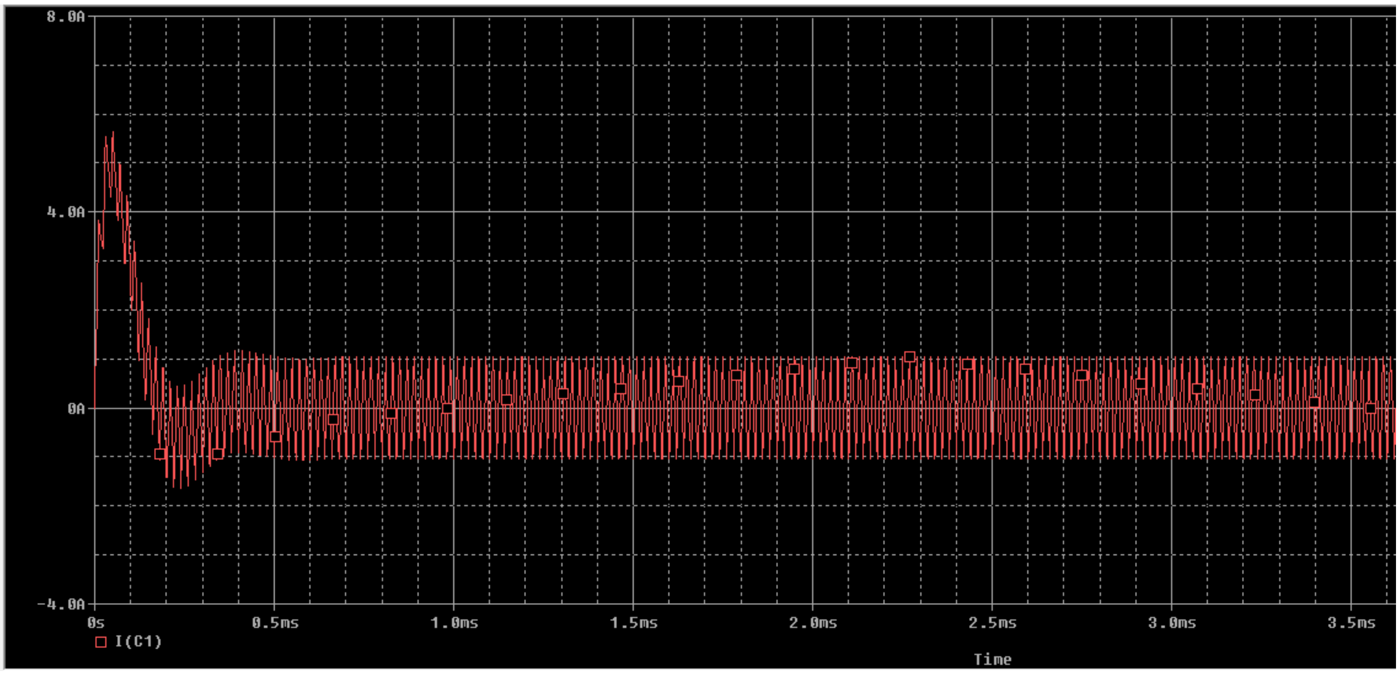
Results

Simulate the circuit and get plots for capacitor current and output voltage.

Capacitor Voltage:

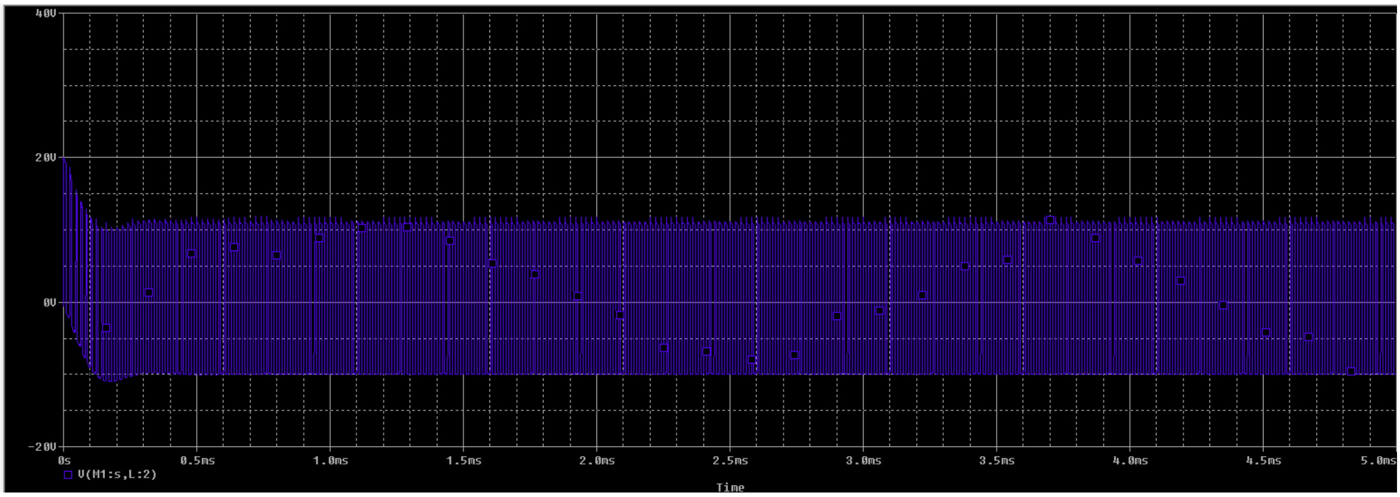


Capacitor Current:

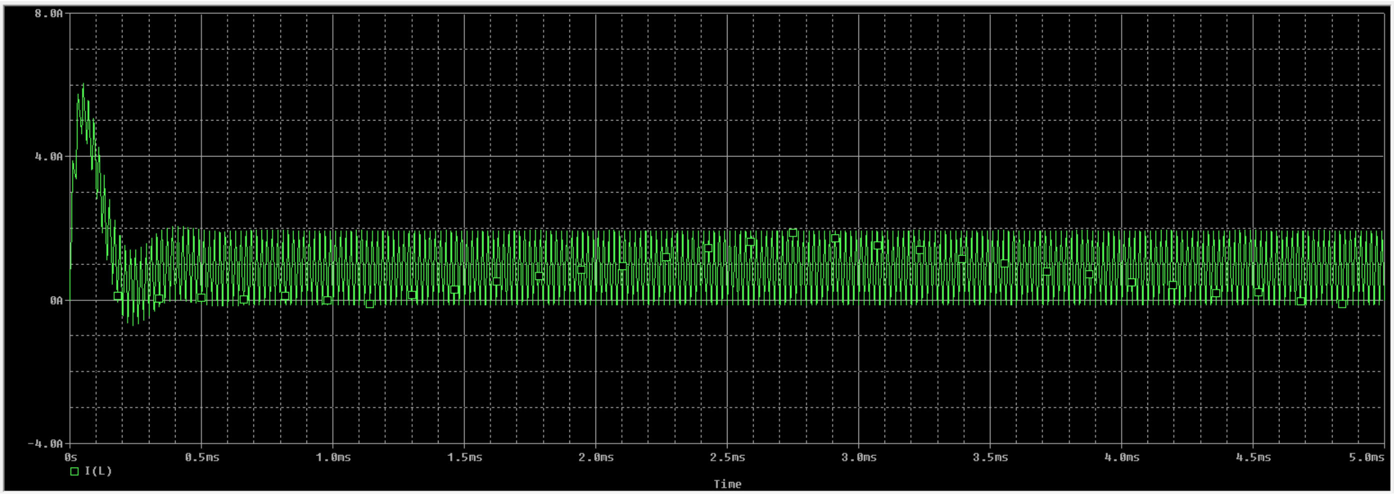


Similarly get plots for inductor current and voltages

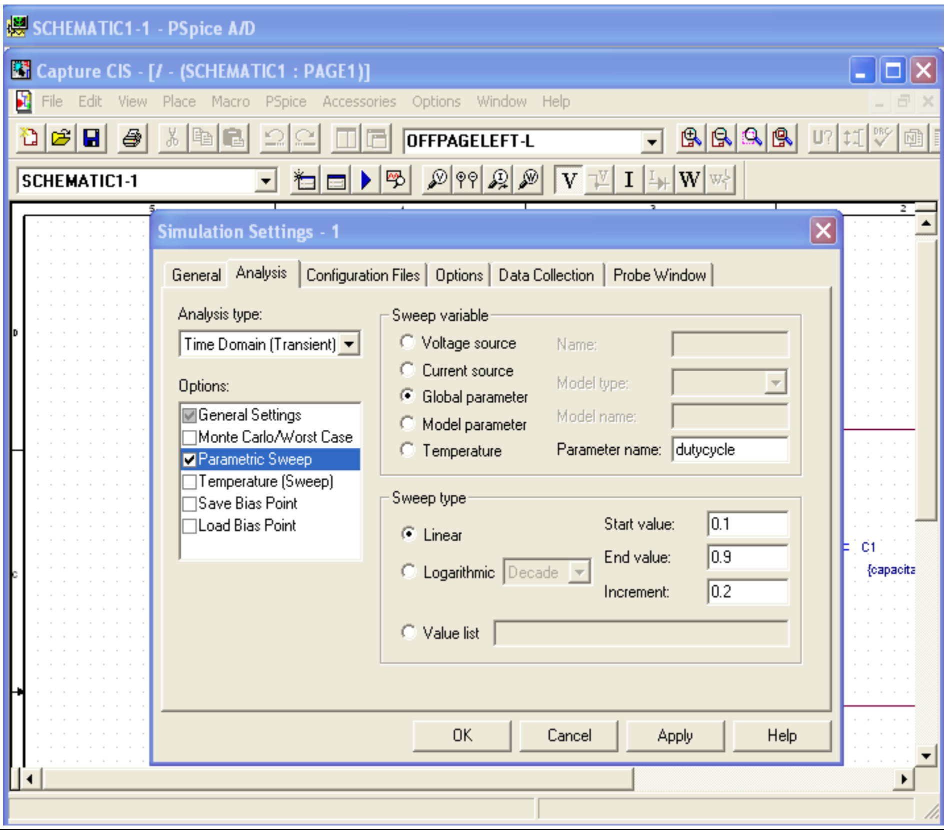
Inductor Voltage:

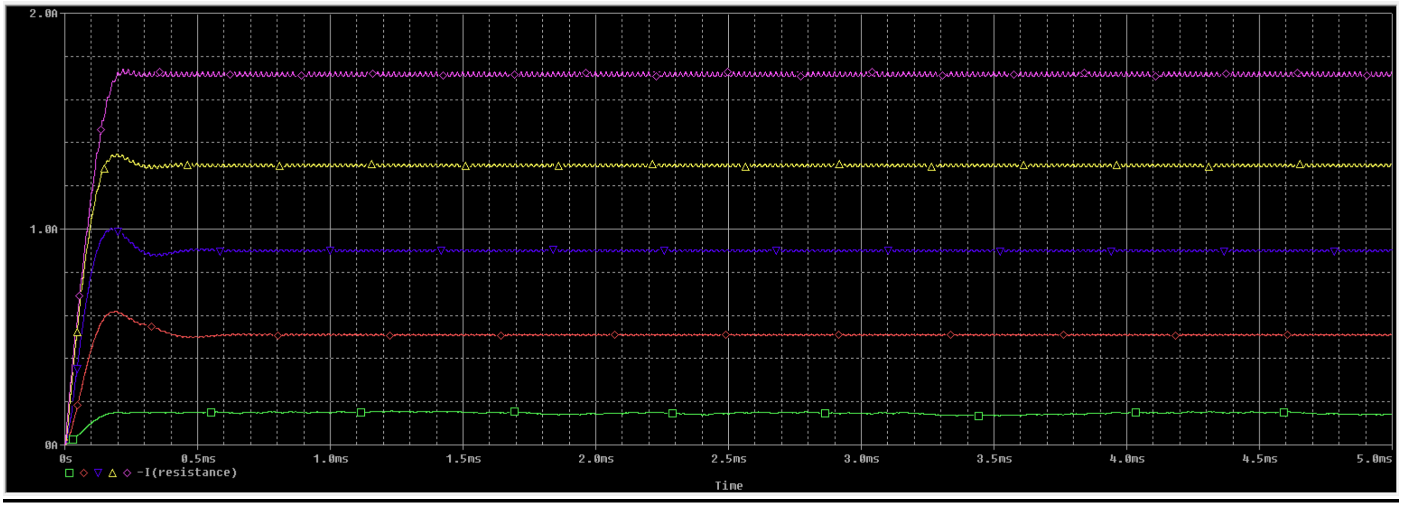


Inductor Current:

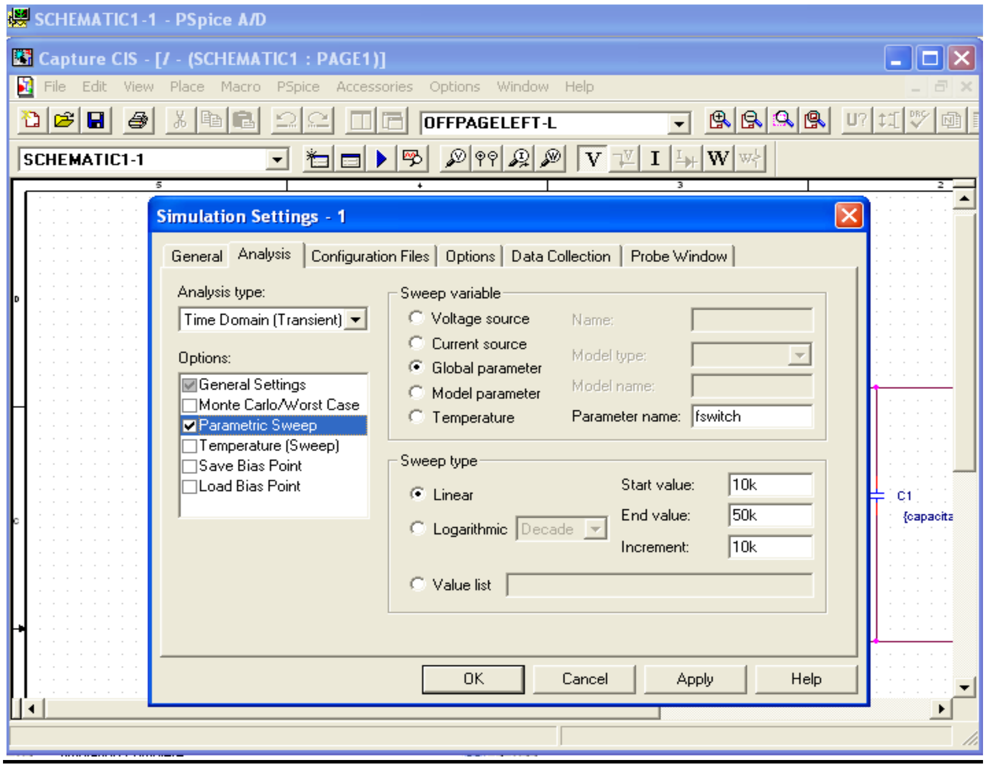


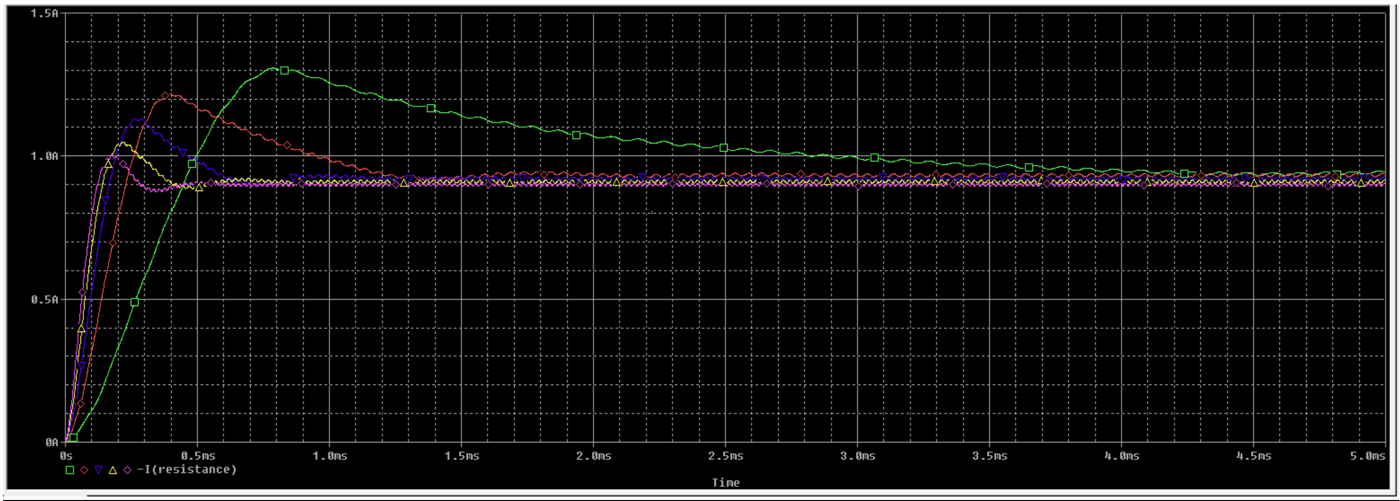
<u>For getting plots for load current at different values of duty cycle use "Parametric sweep" from "Simulation parameters settings" and then put "dutycycle" as the parameter name. Specify its start value, end value and increment.</u>





3.Similarly get plots for load current at different switching frequencies





Green is lowest switching frequency

2. Boost Converter

Objective:

To study the operation and characteristics of a boost chopper.

Procedure:

a) Make the circuit for boost converter using the following parts:

- VDC (voltage source)
- VPULSE (voltage source)
- IRF150 (Switch)
- R (Resistance)
- L (Inductance)
- C (Capacitance)
- DIN4002 (Diode)
- GND_SIGNAL/CAPSYM
- PARAM (For defining variables and their values)

Double click on the parameter "PARAM" and then use "new column" or "new row" option for adding the variables and their values.

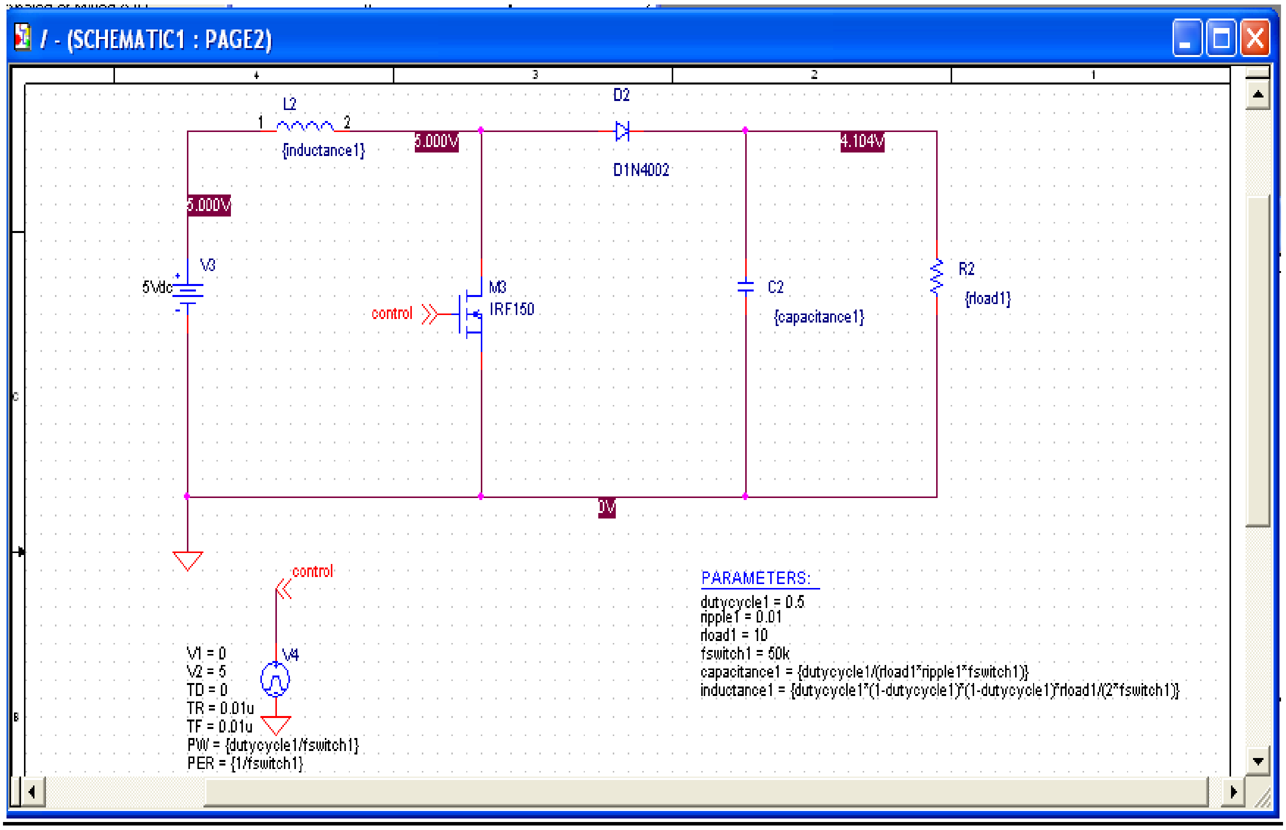
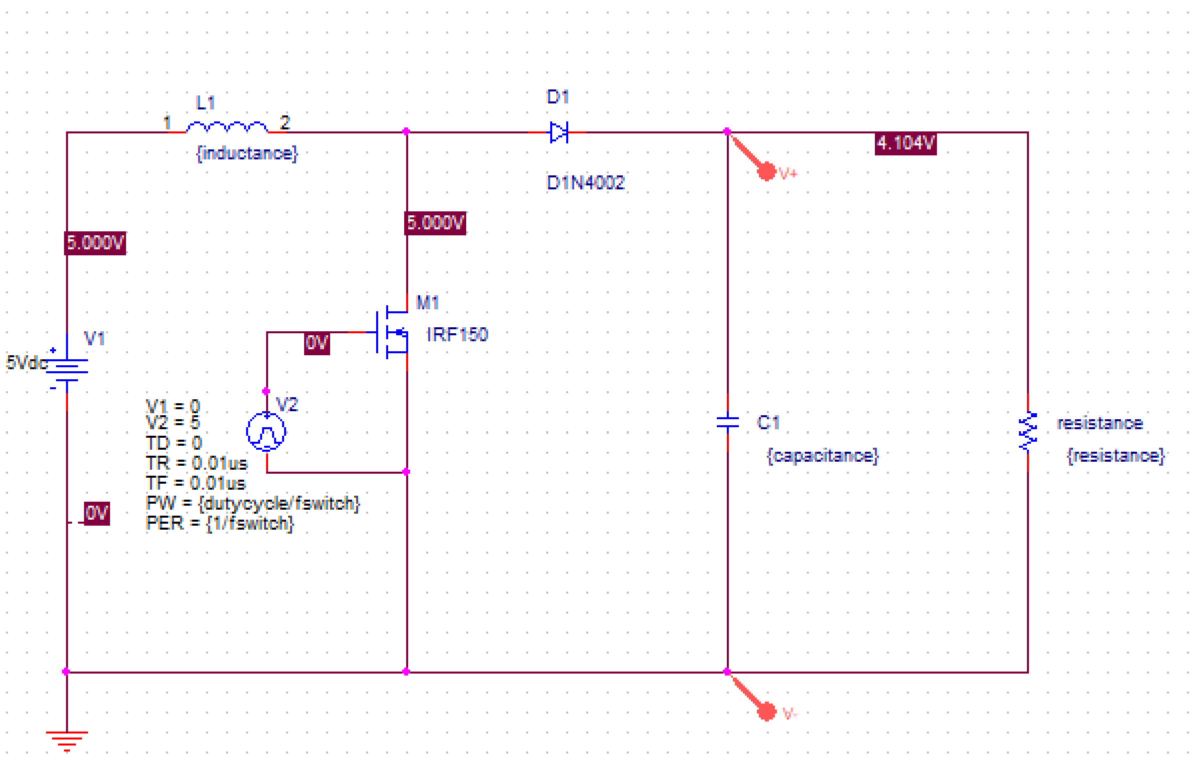
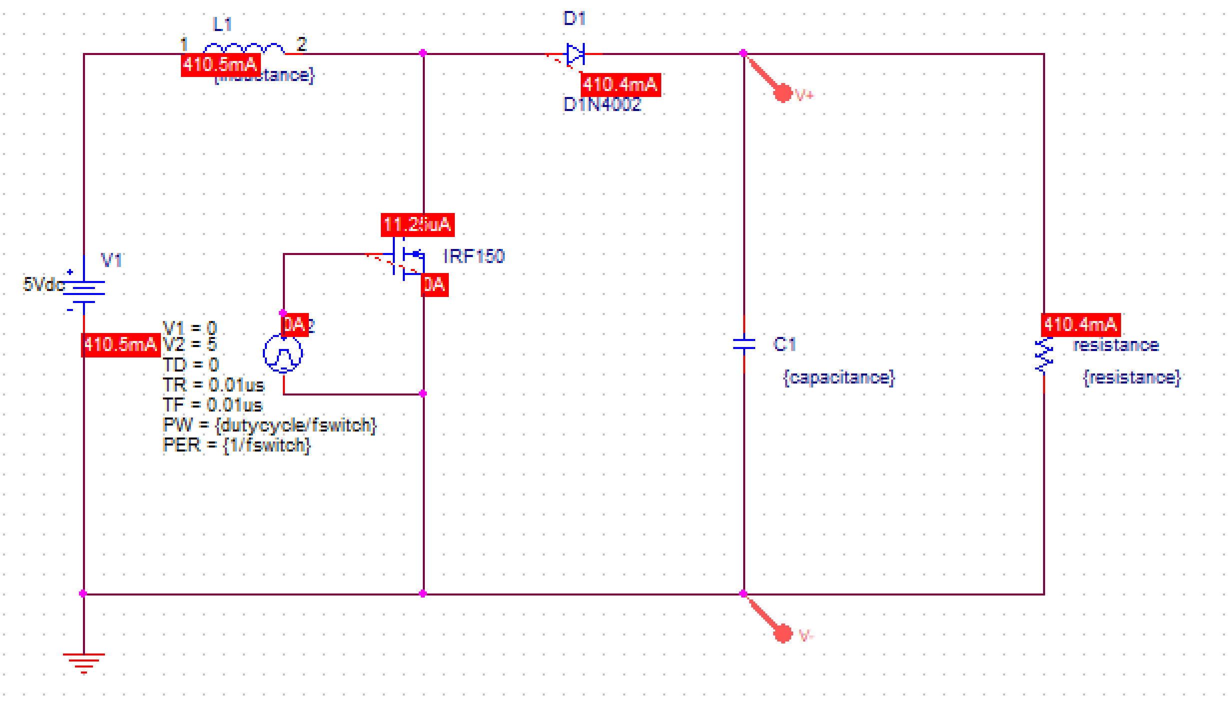


Figure 2 (a).Boost chopper

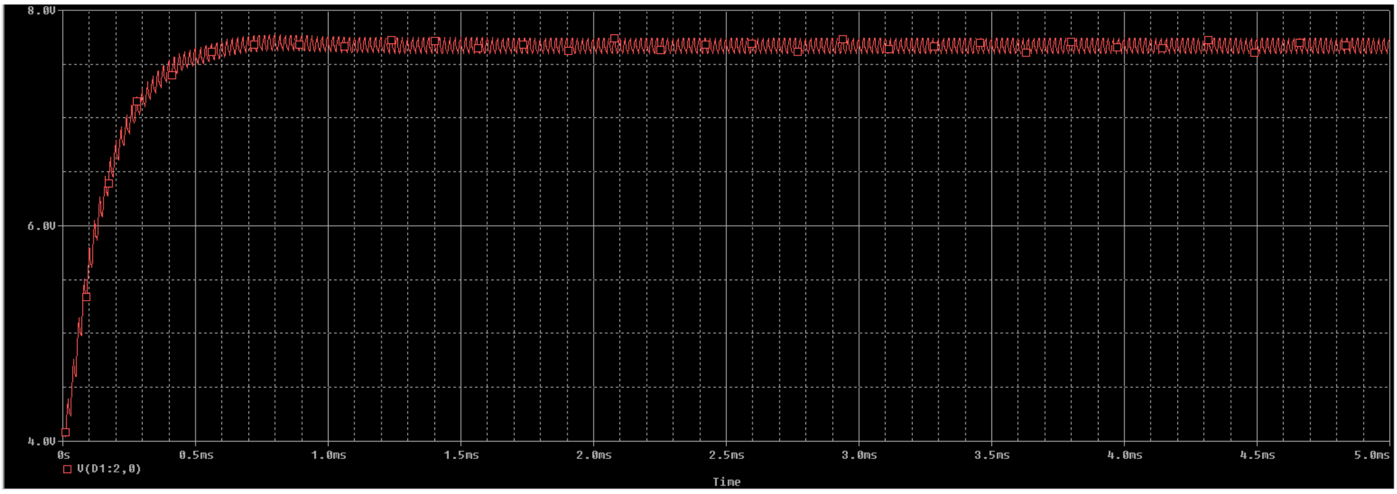
Circuit:



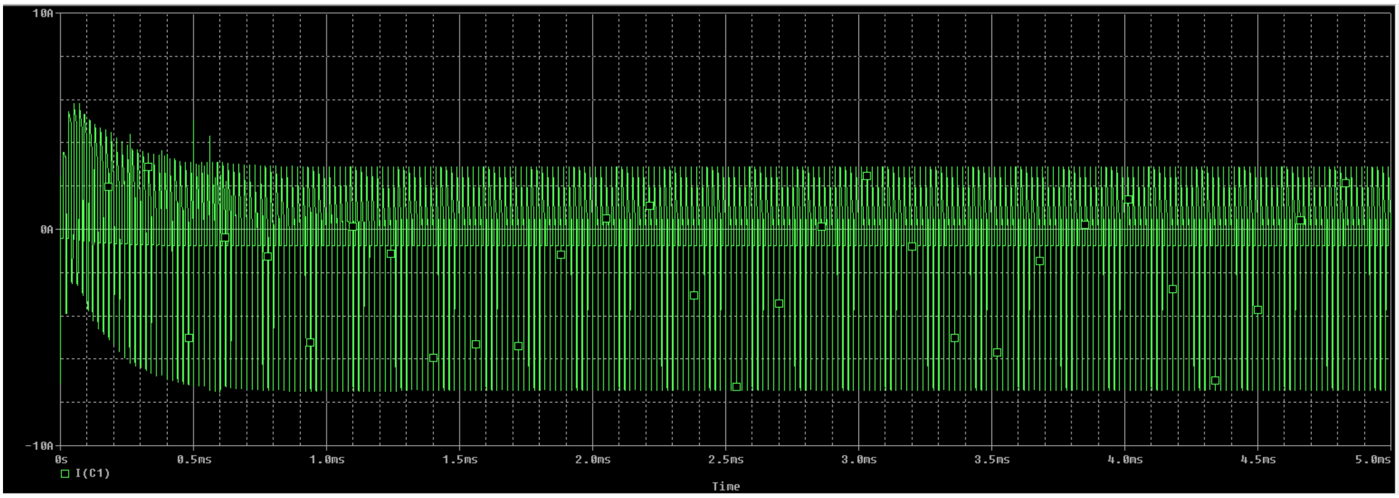


Results:

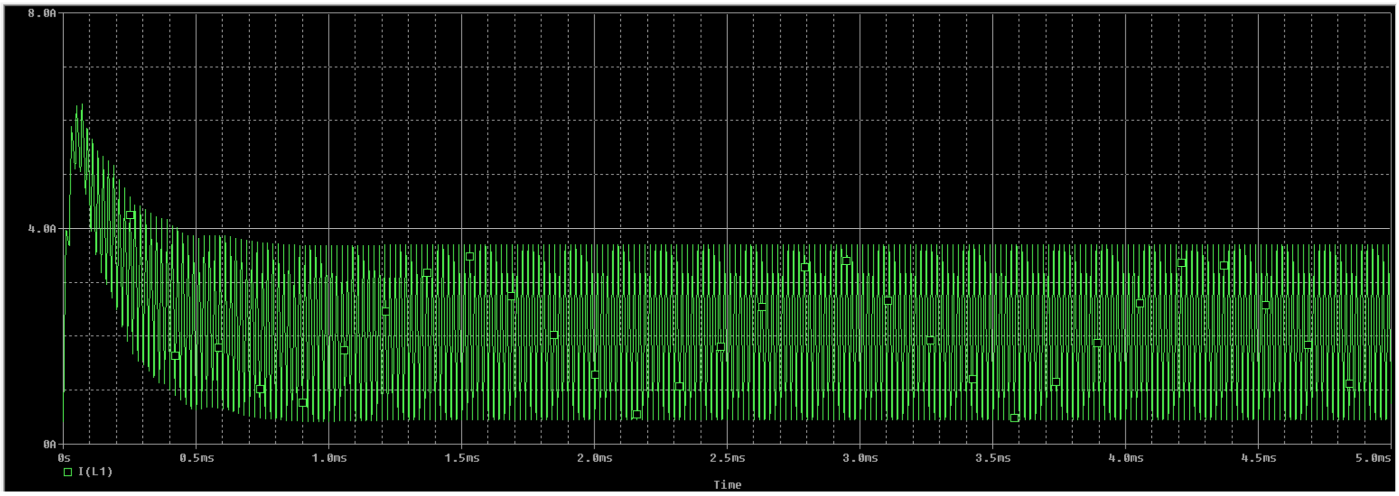
Capacitor Voltage



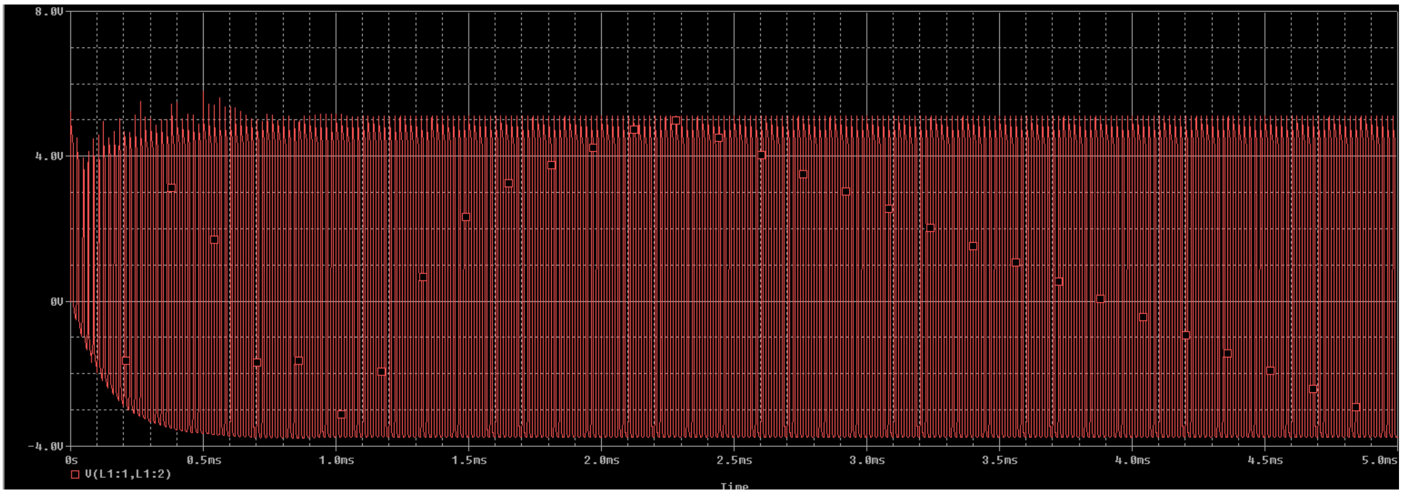
Capacitor Current:



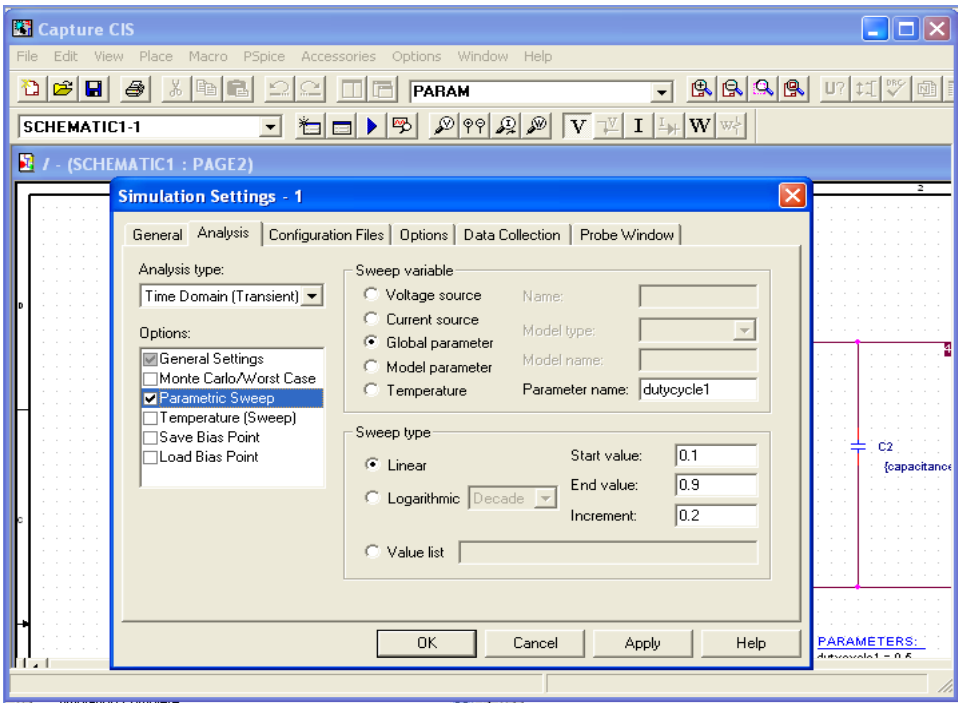
Inductor Current:



Inductor Voltage:

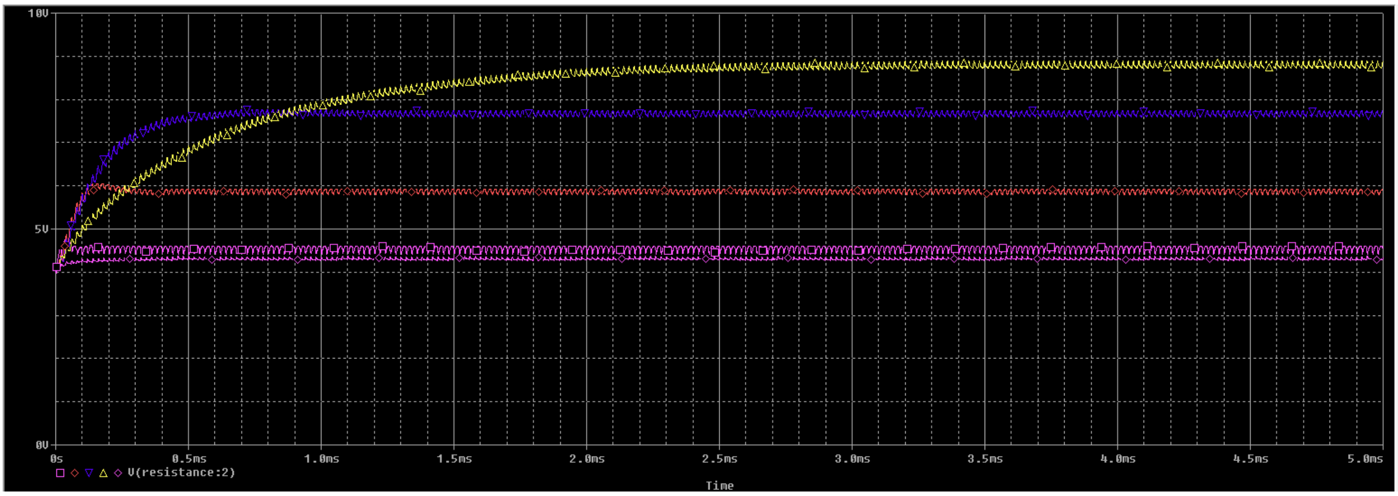


For getting plots for load current at different values of duty cycle use "Parametric sweep" from "Simulation parameters settings" and then put "Duty Cycle" as the parameter name. Specify its start value, end value and increment.

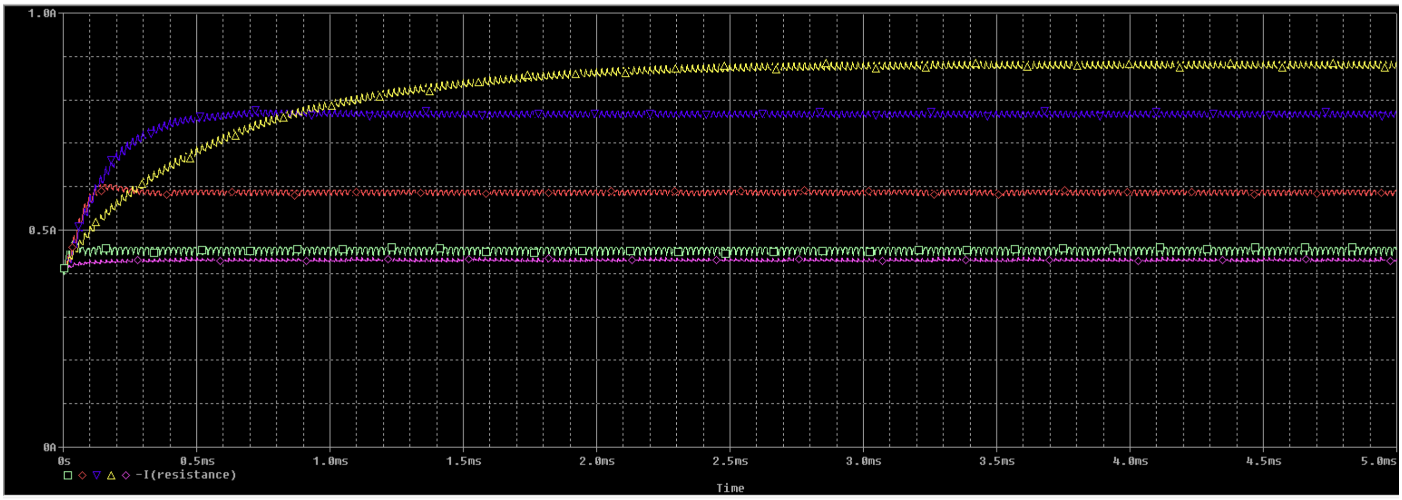


Green Square = 0.1 duty cycle

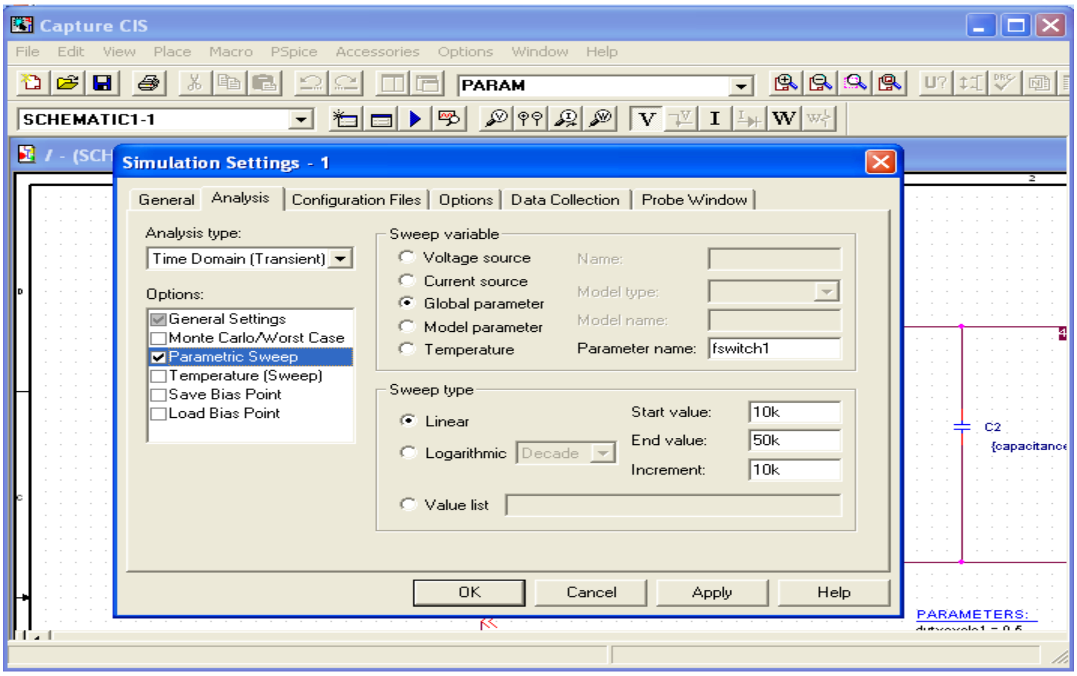
Voltage



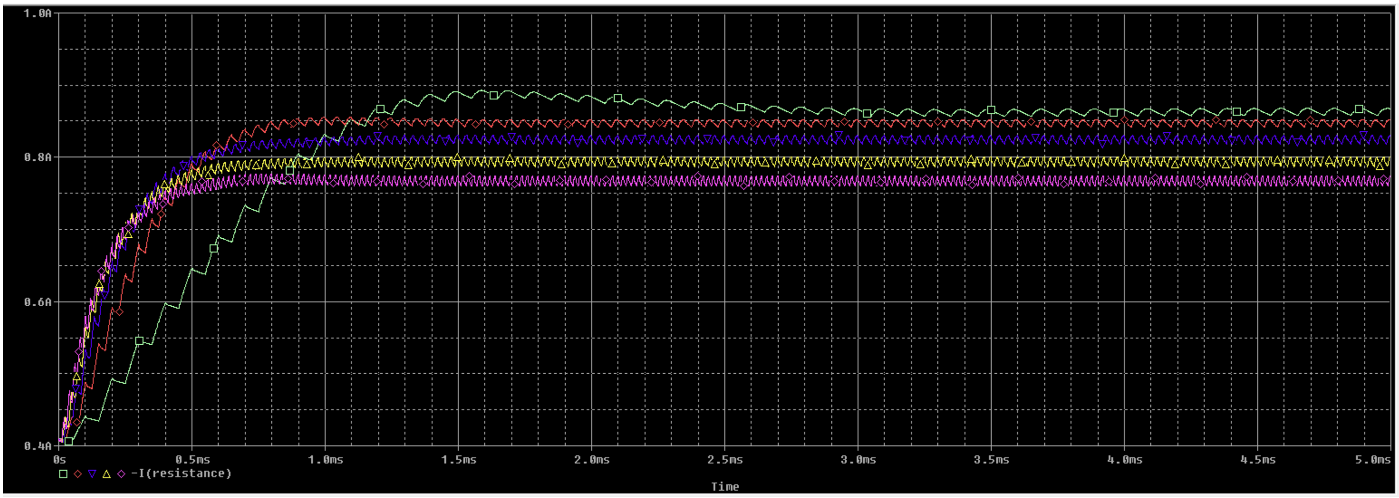
Current:



Similarly get plots for load current at different switching frequencies



Square = 10k



Conclusion:

In this Lab, we implemented buck and boost converter. The buck converter reduces the input voltage by a factor of duty cycle, which is in our case 0.5V. Hence, the output voltage steady state value settles down at 9V due to some voltage drop across inductance in series. Similarly, the boost converter increases the output voltage by a factor of 1/ (duty cycle -1). Hence with an input voltage of 5V, the output voltage is doubled. For Buck Converter, the plot of load current against duty cycle, the small value of duty cycle has less overshoot and hence they settle down to a lower output voltage. However, for the boost converter, the overshoot and the time to settle increases as the duty cycle increases. For the plot of output current against the switching frequency, in buck converter, the output current for higher switching frequency settle down early than the lower and they have a comparatively less overshoot. For boost converter, the higher switching frequency have less ripple and settle early as compare to lower switching frequency. The output current settles down at relatively same value for higher switching frequency.