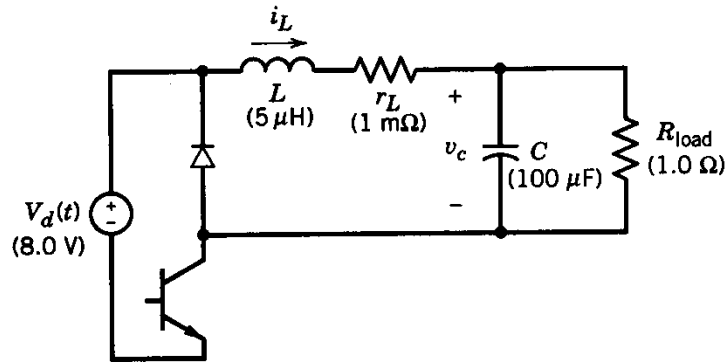


Computer Simulations

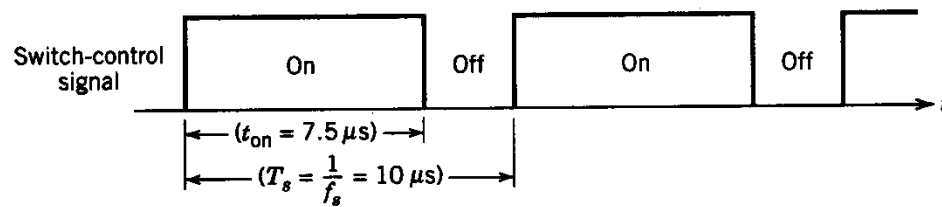
Y. Baghzouz

EE 442-642

Simple Power Electronic Circuit



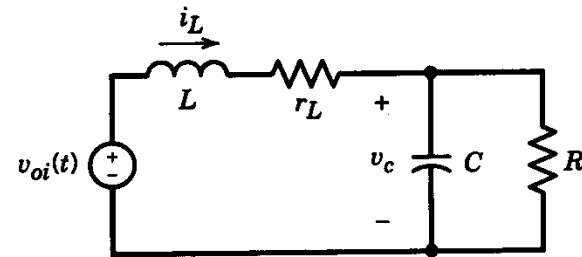
(a)



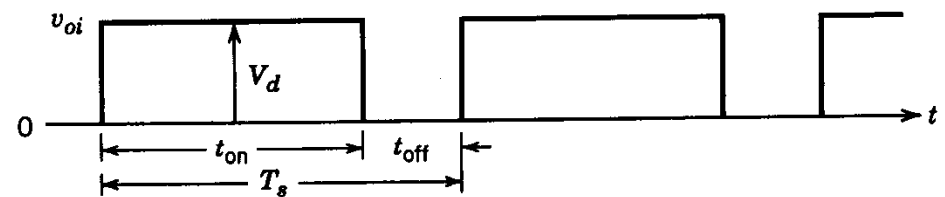
(b)

Step-Down (Buck) Converter

Equivalent Circuit

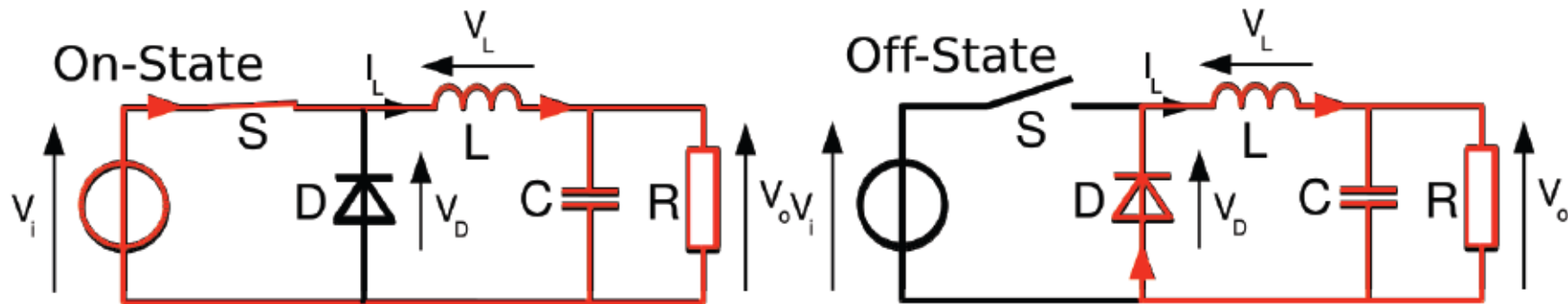


(a)



(b)

Circuit Equations: 2 States



Switch is On

Current flows through the voltage source
Capacitor is charging

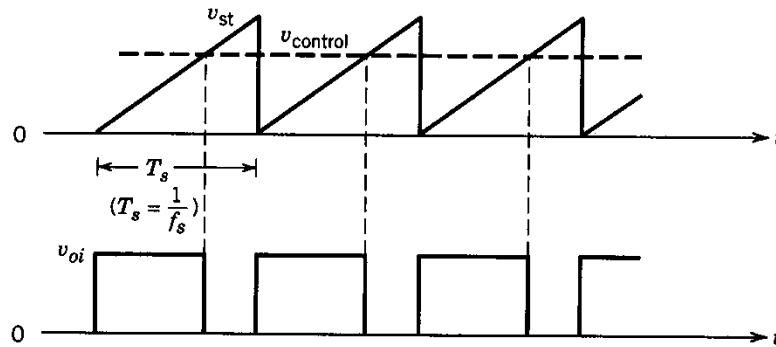
Switch is Off

Current flows through the diode
Capacitor is discharging

$$\begin{pmatrix} \dot{I}_L \\ \dot{V}_o \end{pmatrix} = \begin{pmatrix} 0 & -\frac{1}{L} \\ \frac{1}{C} & -\frac{1}{R_0 C} \end{pmatrix} \begin{pmatrix} I_L \\ V_o \end{pmatrix} + \begin{pmatrix} \frac{V_i}{L} \\ 0 \end{pmatrix} \quad \begin{pmatrix} \dot{I}_L \\ \dot{V}_o \end{pmatrix} = \begin{pmatrix} 0 & -\frac{1}{L} \\ \frac{1}{C} & -\frac{1}{R_0 C} \end{pmatrix} \begin{pmatrix} I_L \\ V_o \end{pmatrix}$$

$$\frac{dx(t)}{dt} = Ax(t) + By(t) \rightarrow x(t) = x(t-dt) + \int_{t-dt}^t [Ax(\zeta) + By(\zeta)] d\zeta$$

MATLAB Simulation



(a)

% Solution of the Circuit in Fig. 4-6 using Trapezoidal Method of Integration.

clc, clg, clear

% Input Data

Vd=8; L=5e-6; C=100e-6; rL=1e-3; R=1.0; fs=100e3; Vcontrol=0.75;

Ts=1/fs; tmax=50*Ts; deltat=Ts/50;

%

time= 0:deltat:tmax;

vst= time/Ts - fix(time/Ts);

voi= Vd * (Vcontrol > vst);

%

A=[-rL/L -1/L; 1/C -1/(C*R)];

b=[1/L 0]';

MN=inv(eye(2) - deltat/2 * A);

M=MN * (eye(2)+ deltat/2 * A);

N=MN * deltat/2 * b;

%

iL(1)=4.0; vC(1)=5.5;

timelength=length(time);

%

for k = 2:timelength

x = M * [iL(k-1) vC(k-1)]' + N * (voi(k) + voi(k-1));

iL(k) = x(1); vC(k) = x(2);

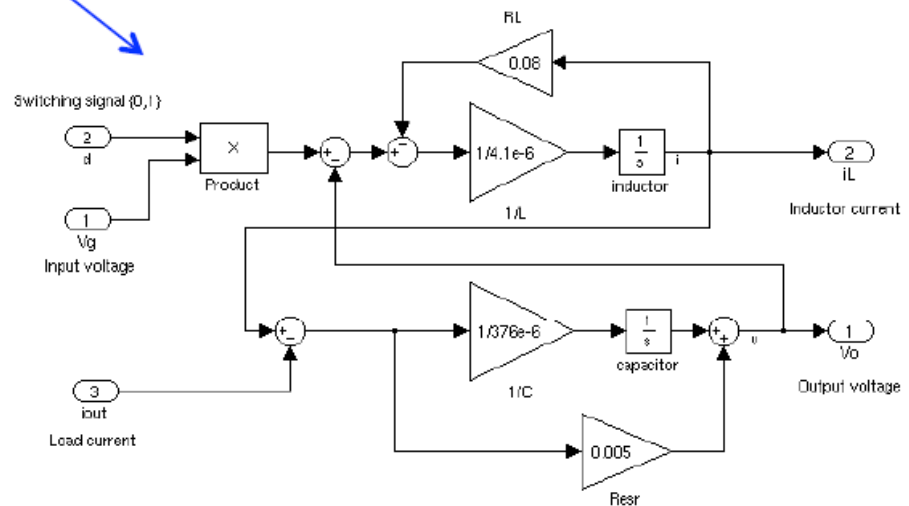
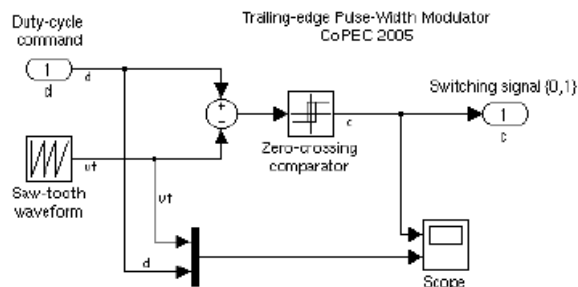
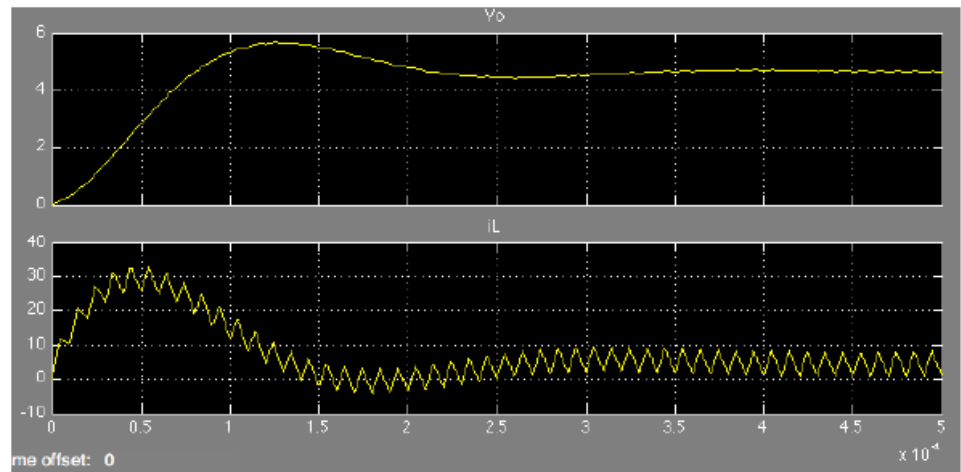
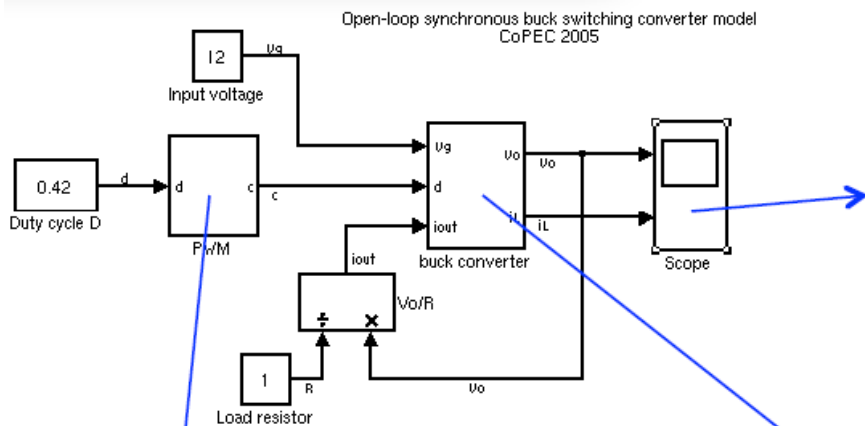
end

%

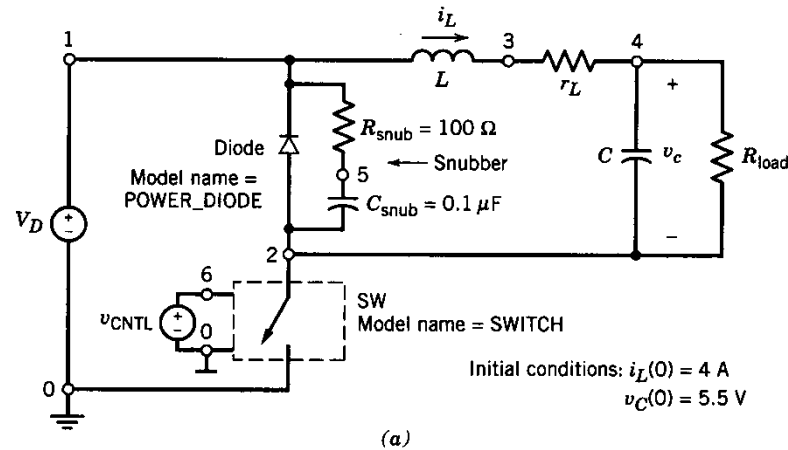
plot(time,iL,time,vC)

meta Example

MATLAB/Simulink Simulation (using SimPowerSystems toolbox)



PSpice Simulation (old version)



PSpice Example

```

*
DIODE 2 1 POWER_DIODE
Rsnub 1 5 100.0
Csnub 5 2 0.1uF
*
SW 2 0 6 0 SWITCH
VCNTL 6 0 PULSE(0V,1V,0s,1ns,1ns,7.5us,10us)
*
L 1 3 5uH IC=4A
rL 3 4 1m
C 4 2 100uF IC=5.5V
RLOAD 4 2 1.0
*
VD 1 0 8.0V
*
.MODEL POWER_DIODE D(RS=0.01,CJO=10pF)
.MODEL SWITCH VSWITCH(RON=0.01)
.TRAN 10us 500.0us 0s 0.2us uic
.PROBE
.END
    
```

PSpice Simulation (new version)

- The schematic version is easy and fast

