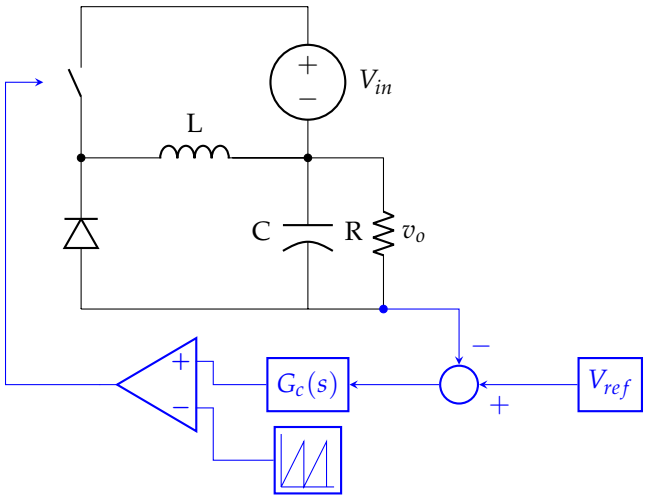
DIGITAL CONTROL OF POWER ELECTRONICS

Voltage Mode Control of Buck-Boost Converter




```
%% Buck Boost voltage mode
clear
Vin = 10
Vo = 10
d = 0.5
L = 100e-6
C = 247e-6
r = 0.01
Po = 20
fsw = 200e3
R = Vo^2/Po

Le = L / (1-d)^2

% plant transfer function

s=tf('s');
opts = bodeoptions('cstprefs');
opts.FreqUnits = 'Hz';

Gp = Vin/(1-d)^2 * (1-s*d*Le/R) * (1+s*r*C) / (Le*C * (s^2 +s*(1/(R*C) + r
    /Le) +1/(Le*C)))
bode(Gp,opts)
grid on
poles = pole(Gp)
zeros = zero(Gp)


% design controller

fc = 1e3
pm = 60
kfb = 1
```

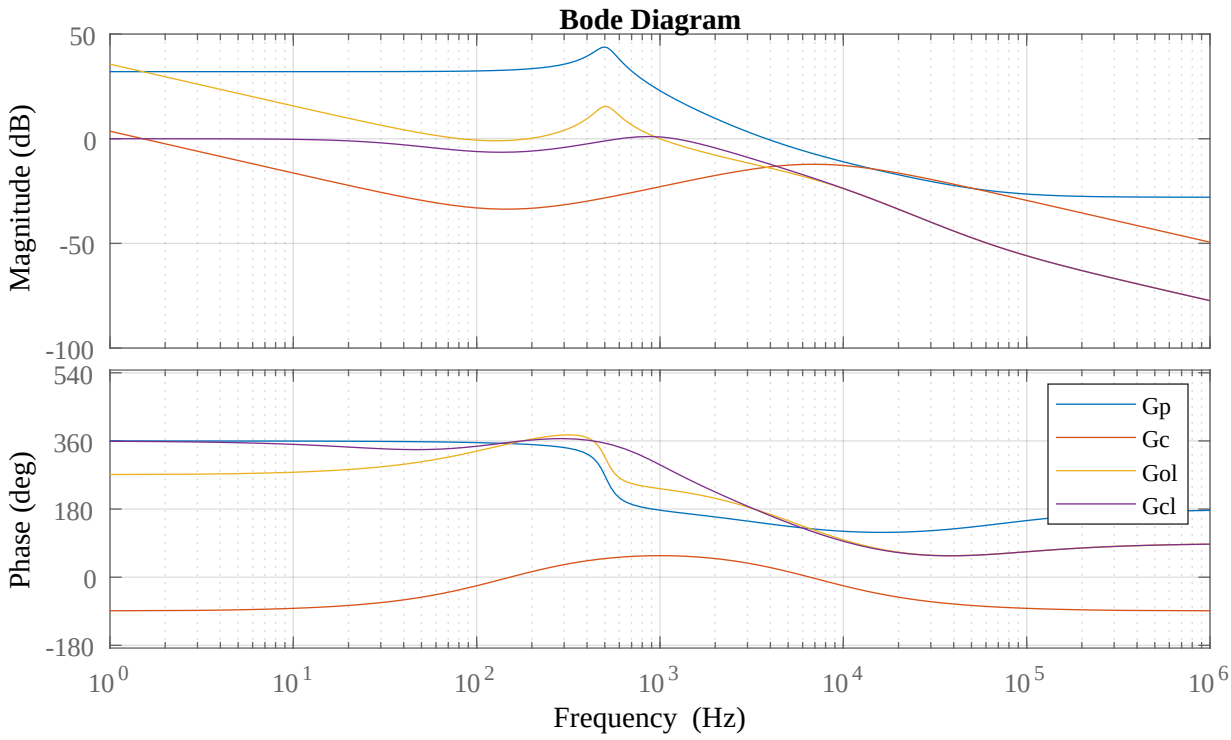
```
Gpwm = 1

[gain phase] = bode(Gp,2*pi*fc)
phase = -phase;
phiboost = -90 + pm - phase
kboost = tand(45 + phiboost/4)
gaincontroller = 1 / (kfb * Gpwm * gain)
fz = fc/kboost
fp = fc*kboost
kc = gaincontroller * 2*pi*fz/kboost
wz = 2*pi*fz
wp = 2*pi*fp

Gc = kc/s * (1+s/(2*pi*fz))^2 / ((1+s/(2*pi*fp))^2);
```

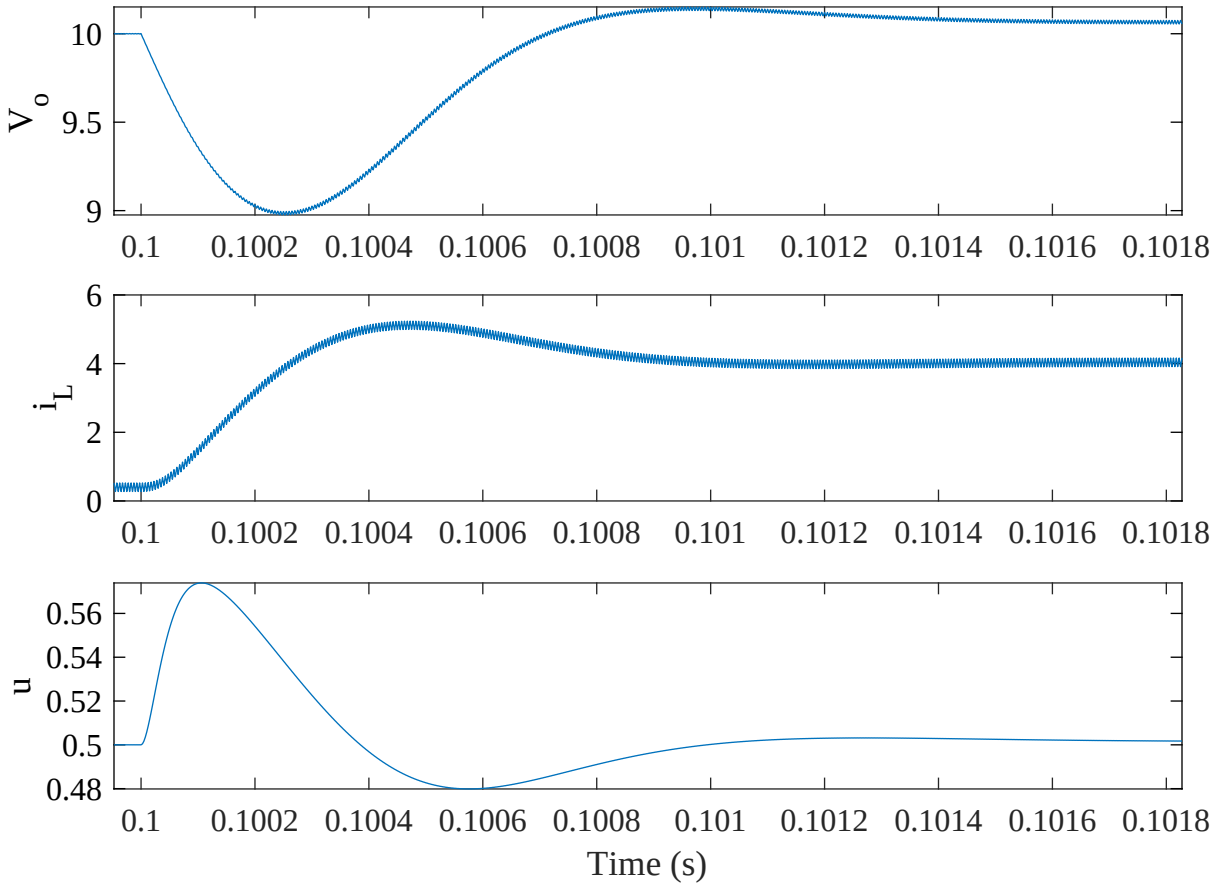
$$G_p(s) = -\frac{1.0\ \left(0.00000001976\,s^2 + 0.007506\,s - 200.0\right)}{0.000000494\,s^2 + 0.00041235\,s + 5.0} \tag{1}$$

$$G_c(s) = \frac{k}{s}\frac{\left(1+\frac{s}{\omega_z}\right)^2}{\left(1+\frac{s}{\omega_p}\right)^2} \tag{2}$$

$$\omega_p = 43215.4874, \omega_z = 913.5248, k = 9.4872 \tag{3}$$

$$p_1 = -63157.2096, p_2 = -43215.4874 + 0.00428044468i, p_3 = -43215.4874 - 0.00428044468i, \\ p_4 = -15299.88, p_5 = -3867.8867 + 4271.1733i, p_6 = -3867.8867 - 4271.1733i, p_7 = -223.5763 \tag{4}$$




V_o
10
9.5
9
i_L
6
4
2
0
u
0.56
0.54
0.52
0.5
0.48
0.1
0.1002
0.1004
0.1006
0.1008
0.101
0.1012
0.1014
0.1016
0.1018
Time (s)