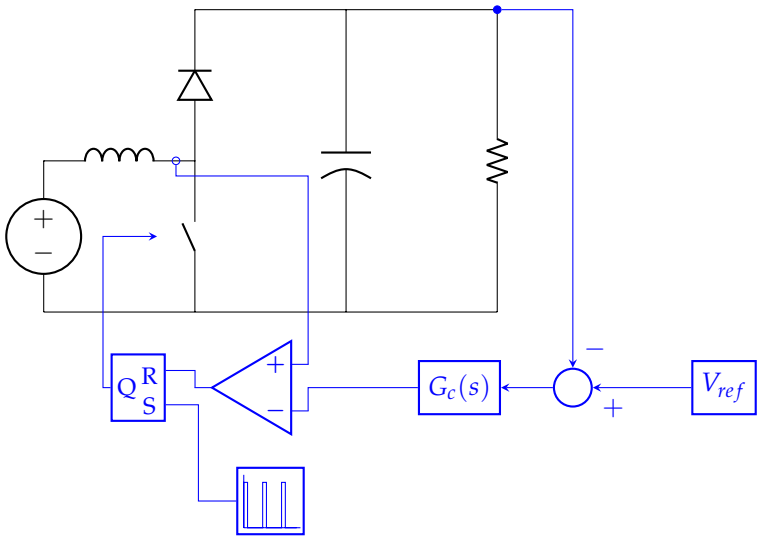
DIGITAL CONTROL OF POWER ELECTRONICS

Digital Current Mode Control of Boost Converter

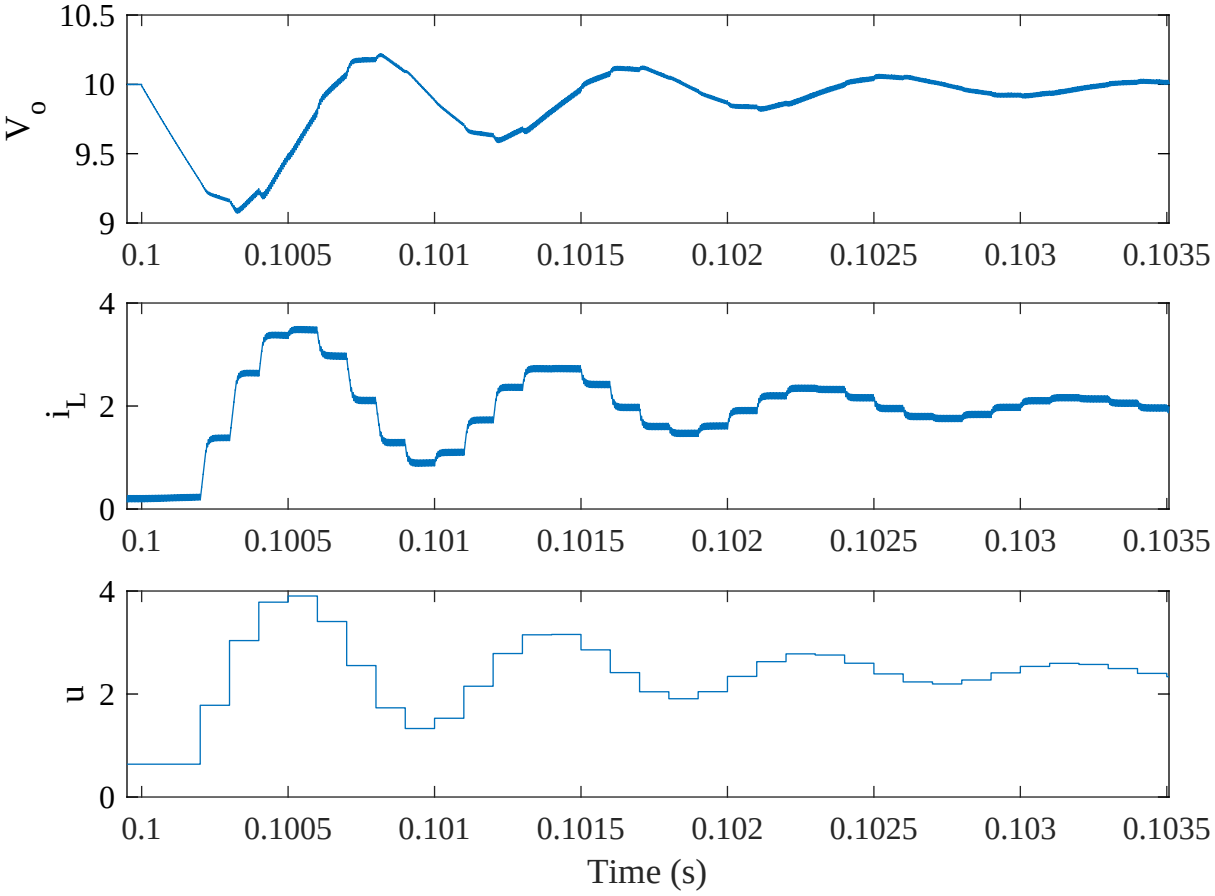



```
clear
Vin = 5
Vo = 10
d = 0.5
L = 100e-6
C = 247e-6
r = 0.01
Po = 10
fsw = 200e3
R = Vo^2/Po

Le = L / (1-d)^2

% plant transfer function

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

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


% design controller

fc = 1e3
pm = 60
```

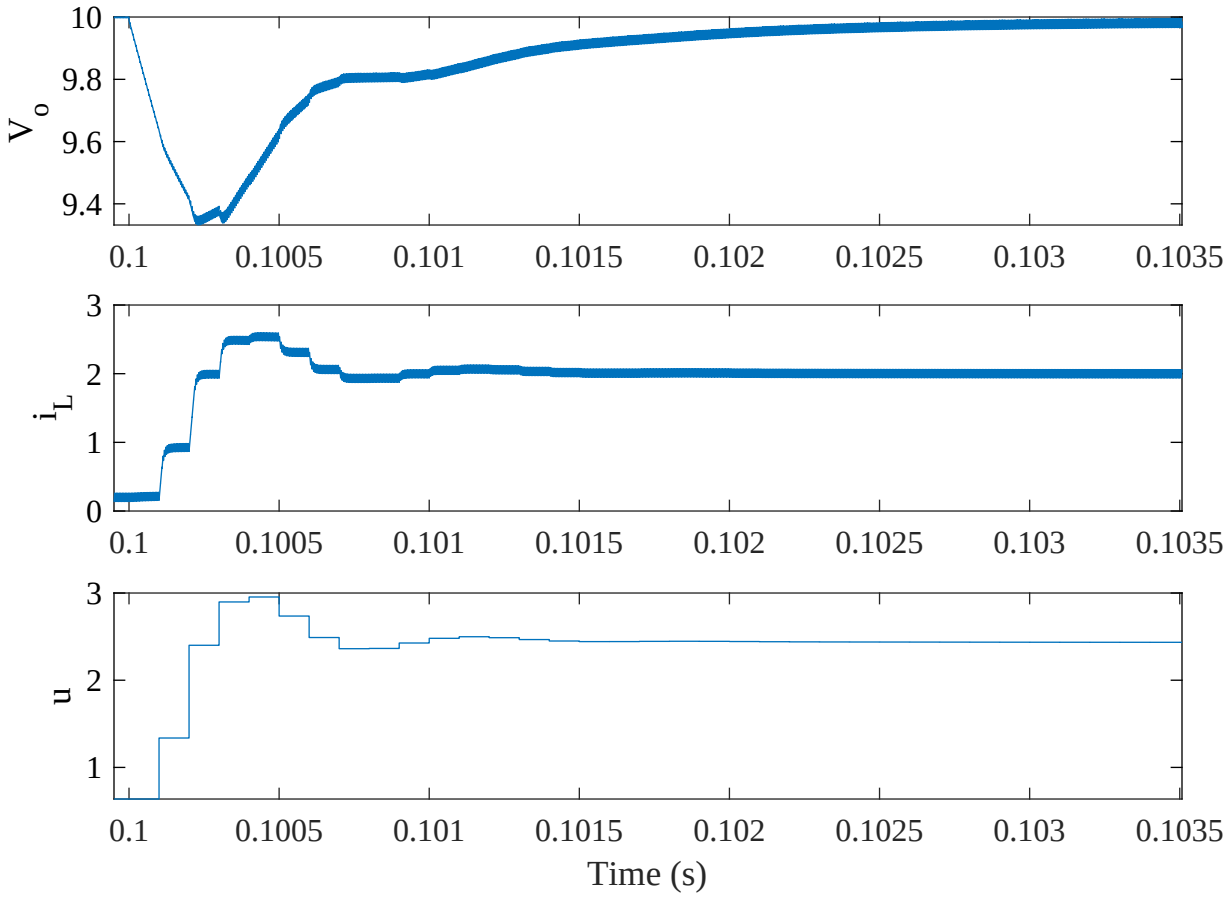
```
kfb = 1
Gpwm = 1

[gain_gp angle_gp] = bode(Gp,2*pi*fc)
phiboost = -90 +pm-angle_gp
gain_need = 1/gain_gp
Kboost = tand(45+phiboost/2)
fz = fc/Kboost
fp = Kboost*fc
kc = 2*pi*fz/gain_gp
wz = 2*pi*fz
wp = 2*pi*fp

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

```
% digital controllers
Ts = 1/10e3
Z=tf('z',Ts)
sback = ((Z-1)/(Z*Ts))
gc_dig_backward_10k = minreal(kc/sback * (1+sback/(2*pi*fz)) / ((1+sback
   /(2*pi*fp))))
gc_dig_zoh_10k = c2d(minreal(Gc),Ts,'zoh')
gc_dig_tustin_10k = c2d(minreal(Gc),Ts,'tustin')

Ts = 1/50e3
Z=tf('z',Ts)
sback = ((Z-1)/(Z*Ts))
gc_dig_backward_50k = minreal(kc/sback * (1+sback/(2*pi*fz)) / ((1+sback
   /(2*pi*fp))))
gc_dig_zoh_50k = c2d(minreal(Gc),Ts,'zoh')
gc_dig_tustin_50k = c2d(minreal(Gc),Ts,'tustin')
```

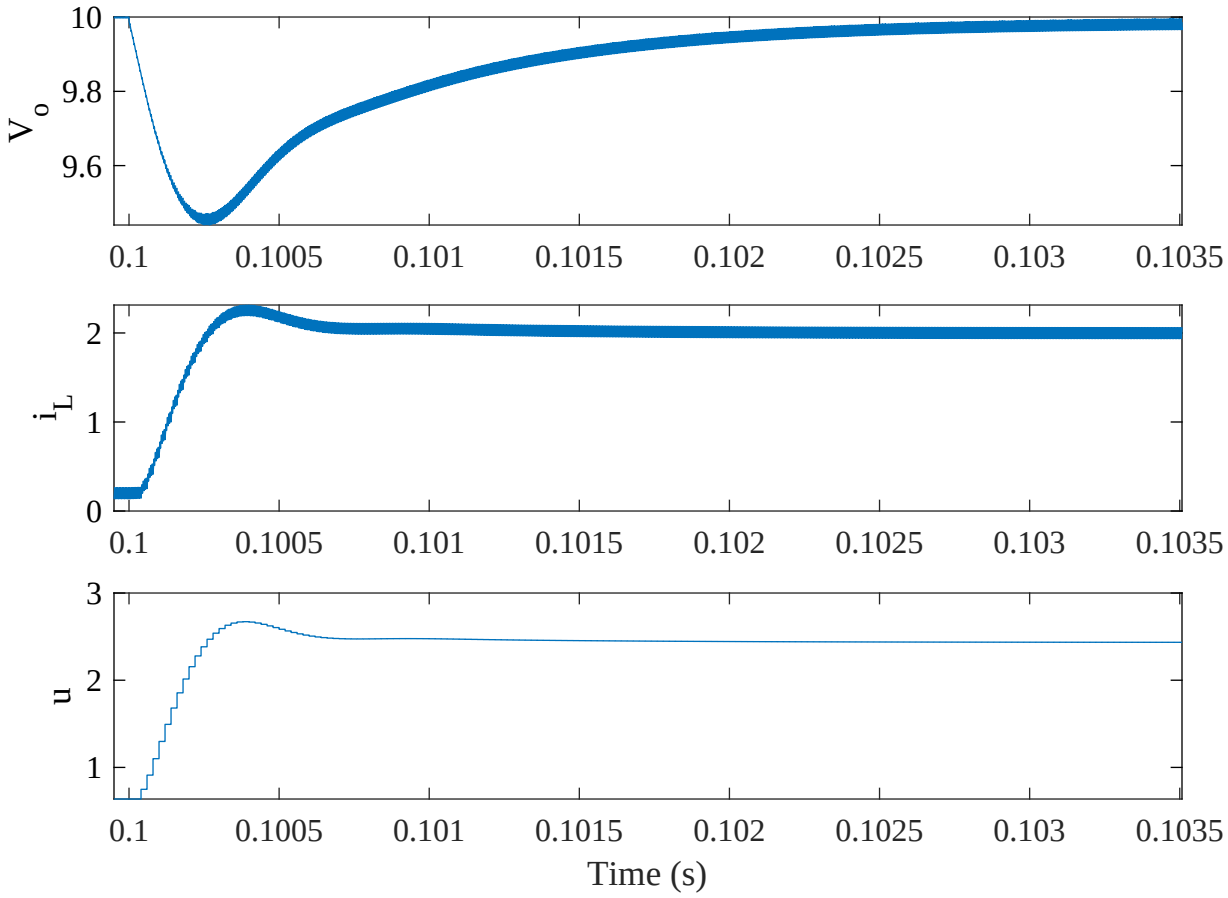
$$G_c(z) = \frac{2.5687\,z^2 - 2.2646\,z}{z^2 - 1.2538\,z + 0.25379} \tag{1}$$



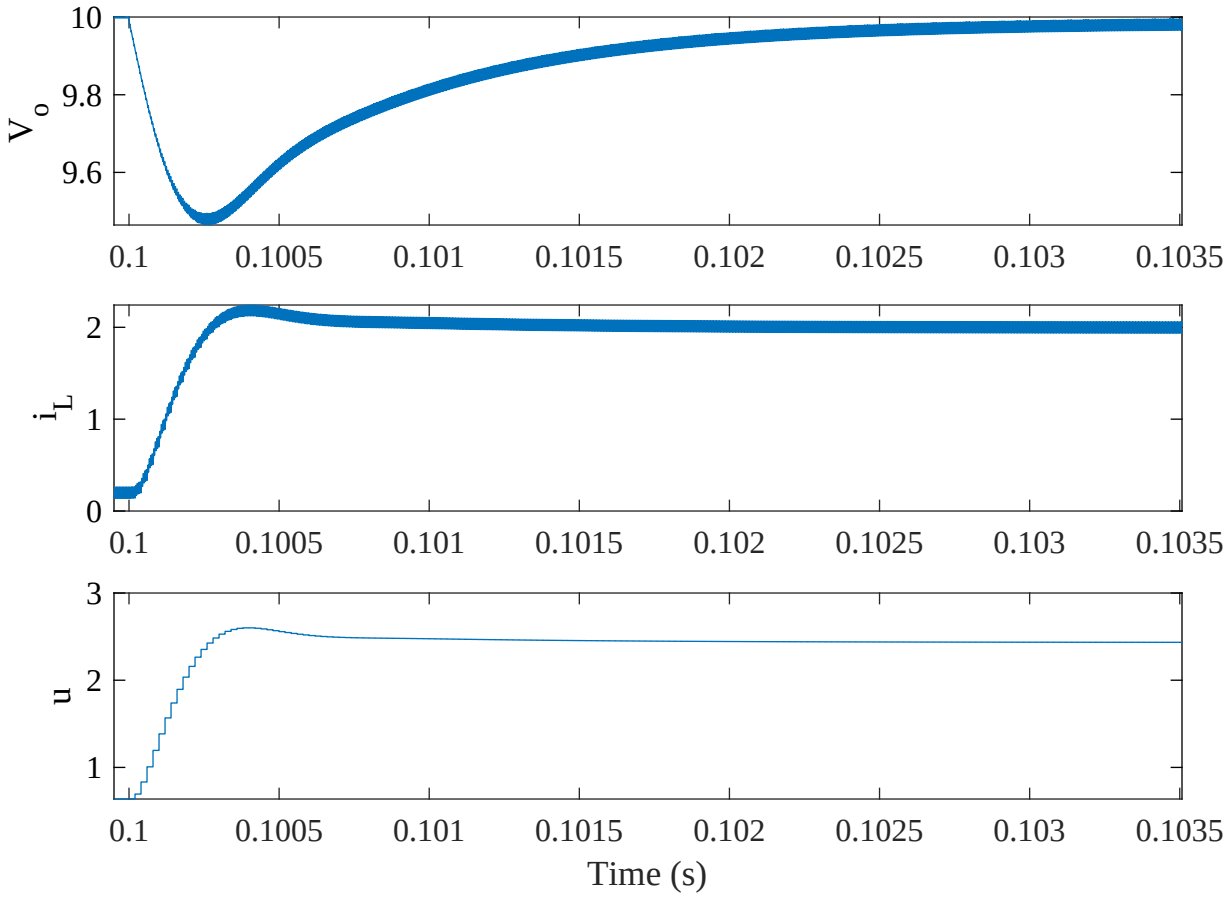
$$G_c(z) = \frac{1.9275\,z^2 + 0.24251\,z - 1.685}{z^2 - 0.80967\,z - 0.19033} \tag{2}$$

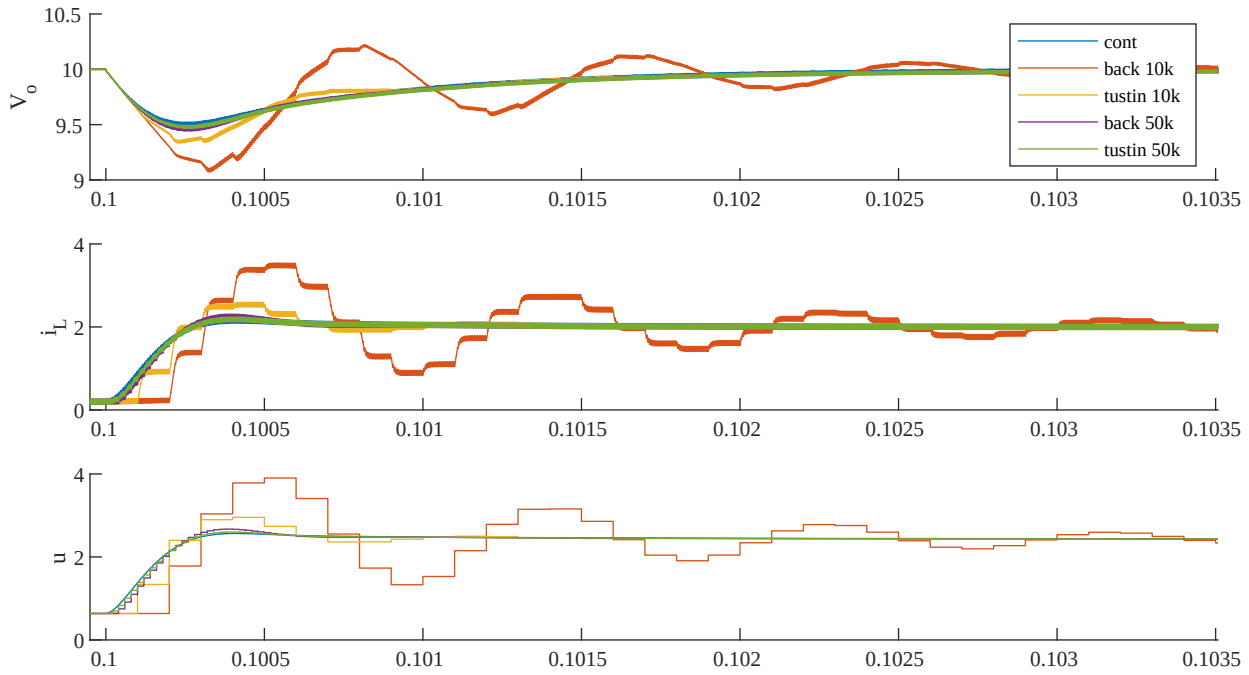


$$G_c(z) = \frac{1.154z^2 - 1.124z}{z^2 - 1.6297\,z + 0.6297} \tag{3}$$



$$G_c(z) = \frac{0.69883\,z^2 + 0.018517\,z - 0.68031}{z^2 - 1.5456\,z + 0.54556} \tag{4}$$




10.5
10
9.5
9
V_o
cont
back 10k
tustin 10k
back 50k
tustin 50k
0.1
0.1005
0.101
0.1015
0.102
0.1025
0.103
0.1035
4
2
0
i_L
u