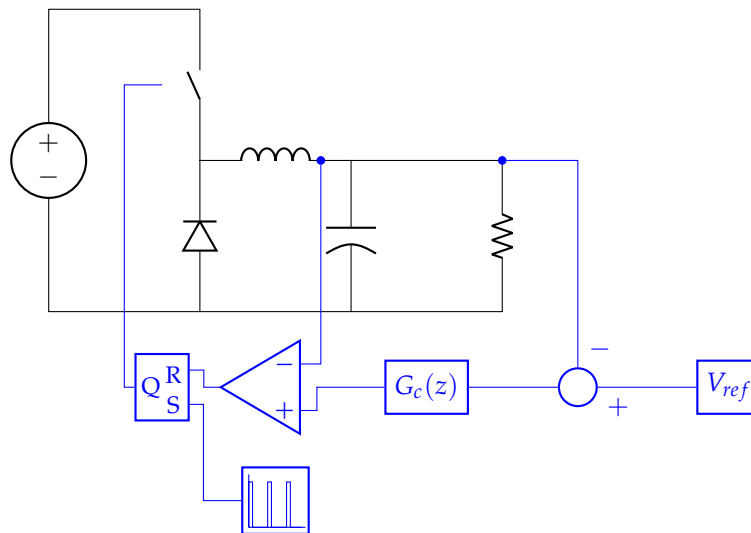


DIGITAL CONTROL OF POWER ELECTRONICS

Current Mode Control of Buck Converter



```

1 clear
2
3 Vin = 30
4 L = 200e-6
5 C = 400e-6
6 r = 0.1
7 R = 5
8
9 fc = 1000 % select bandwidth
10 pm = 60 % select phase margin
11 w = 2*pi*fc
12 T = 1/100e3
13
14 gain_gps = abs(R*(1+j*w*r*C)/(1+j*w*R*C))
15 angle_gps = angle(R*(1+j*w*r*C)/(1+j*w*R*C))*180/pi
16
17 phiboost = -90 +pm-angle_gps
18 gain_need = 1/gain_gps
19
20 Kboost = tand(45+phiboost/2)
21 fz = fc/Kboost
22 fp = Kboost*fc
23 kc = 2*pi*fz/gain_gps
24
25 wz = 2*pi*fz
26 wp = 2*pi*fp
27
28 s=tf('s');
29 Gc = kc/s * (1+s/(2*pi*fz)) / ((1+s/(2*pi*fp)));
30 Gps = R*(1+s*r*C)/(1+s*R*C);
31 Gol = Gps*Gc;
32 Gcl = Gol/(1+Gol)

```

```

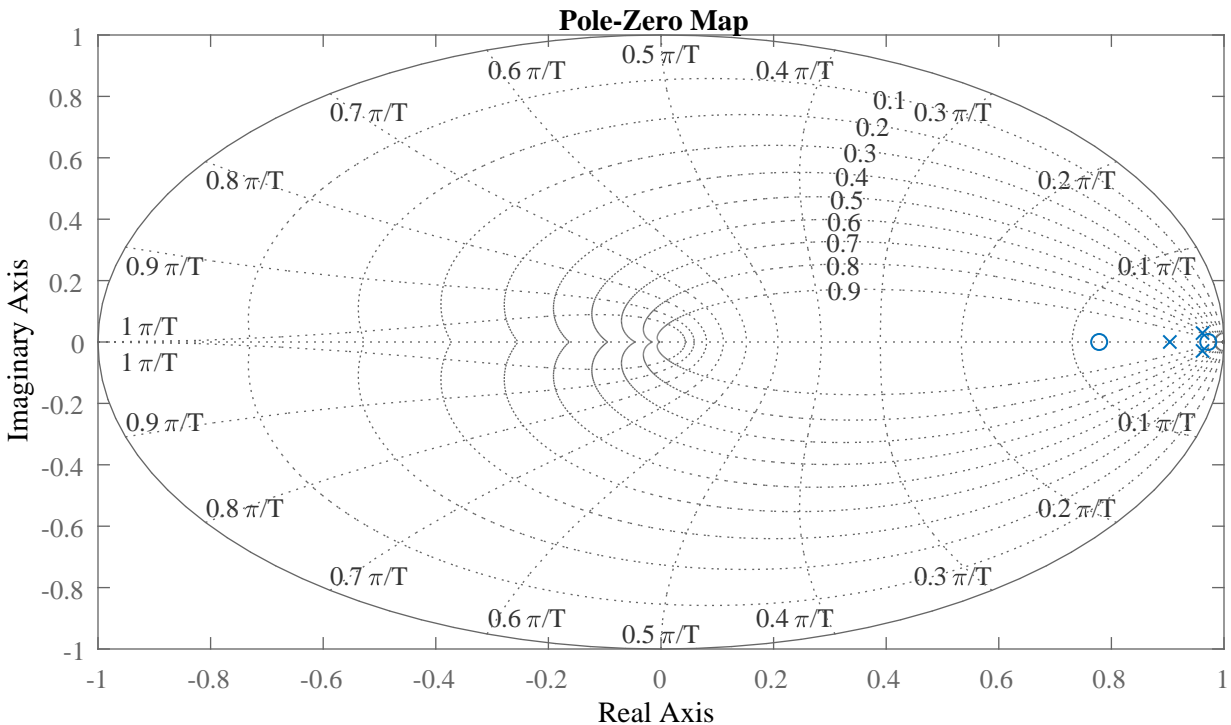
33
34 Z = tf('z',T)
35 Gc_dig_backward = minreal(kc/((Z-1)/(Z*T)) * (1+((Z-1)/(Z*T))/(2*pi*fz)) /
    ((1+((Z-1)/(Z*T))/(2*pi*fp))))
36 Gp_dig_backward = minreal(R*(1+((Z-1)/(Z*T))*r*C)/(1+((Z-1)/(Z*T))*R*C))
37 Gc_dig_zoh = c2d(Gc,T,'zoh')
38 Gc_dig_tustin = c2d(Gc,T,'tustin')
39
40 Gcl_dig_backward = minreal(Gc_dig_backward*Gp_dig_backward/(1+
    Gc_dig_backward*Gp_dig_backward))
41 Gcl_dig_zoh = c2d(minreal(Gcl),T,'zoh')
42 Gcl_dig_tustin = c2d(minreal(Gcl),T,'tustin')
43
44 pole(Gcl_dig_backward)
45 zero(Gcl_dig_backward)

```

$$G_c(z) = \frac{0.1611z^2 + 0.004513z - 0.1566}{z^2 - 1.87z + 0.8701} \quad (1)$$

The digital closed loop transfer function is as follows.

$$G_{cl}(z) = \frac{0.03676z^3 - 0.06515z^2 + 0.02859z}{z^3 - 2.833z^2 + 2.674z - 0.8415} \quad (2)$$

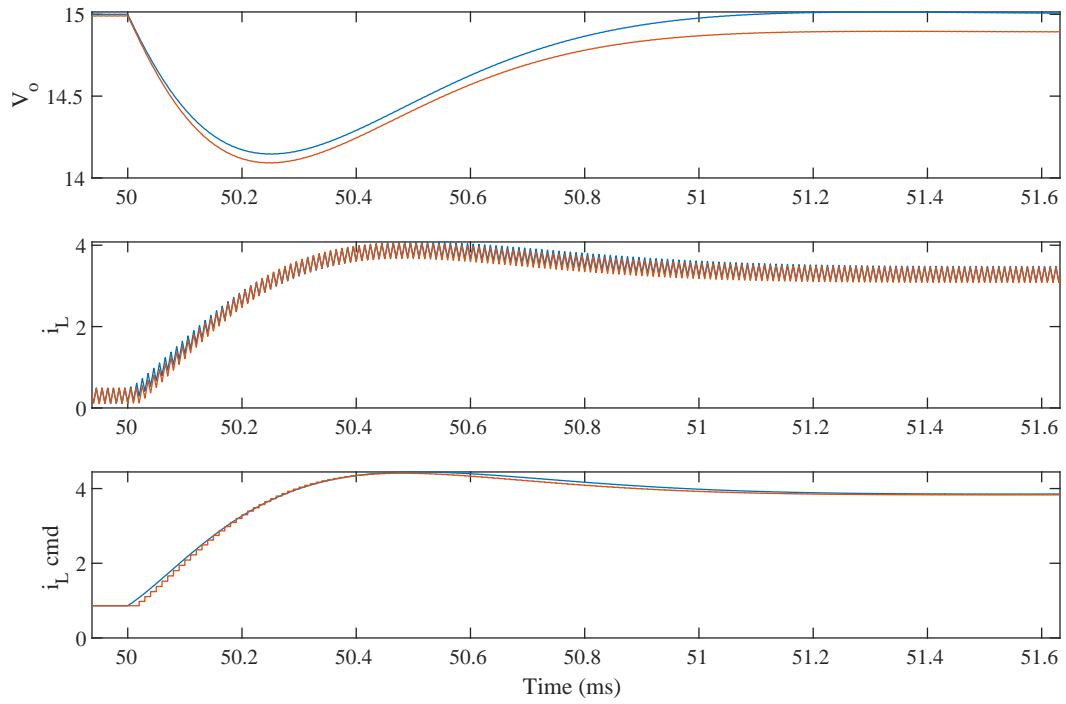


The poles are located at

$$p_1 = 0.9622 + 0.0280i \quad p_2 = 0.9622 - 0.0280i \quad p_3 = 0.9082 \quad (3)$$

The zeros are located at

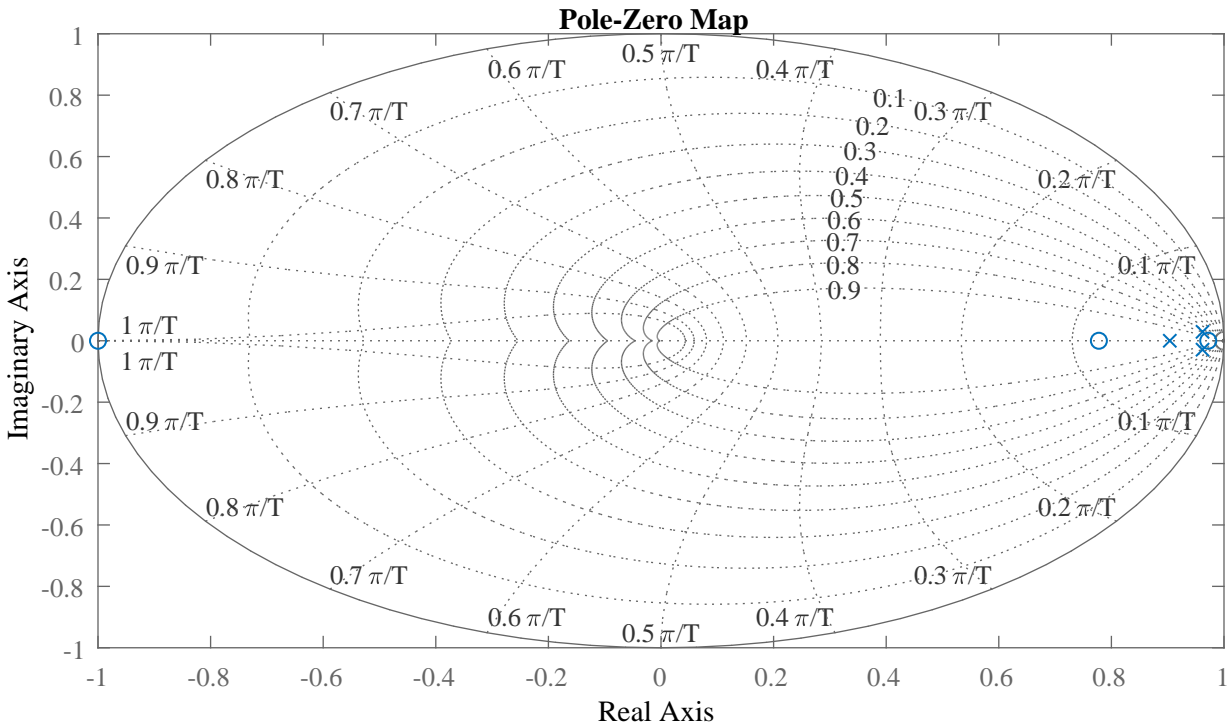
$$z_1 = 0.9724 \quad z_2 = 0.8000 \quad z_3 = 0 \quad (4)$$



$$G_c(z) = \frac{0.1611z^2 + 0.004513z - 0.1566}{z^2 - 1.87z + 0.8701} \quad (5)$$

The digital closed loop transfer function is as follows.

$$G_{cl}(z) = \frac{0.01776z^3 - 0.01332z^2 - 0.01765z + 0.01343}{z^3 - 2.828z^2 + 2.665z - 0.8369} \quad (6)$$



The poles are located at

$$p_1 = 0.9619 + 0.0290i \quad p_2 = 0.9619 - 0.0290i \quad p_3 = 0.9037 \quad (7)$$

The zeros are located at

$$z_1 = -1 \quad z_2 = 0.9720 \quad z_3 = 0.7778 \quad (8)$$

