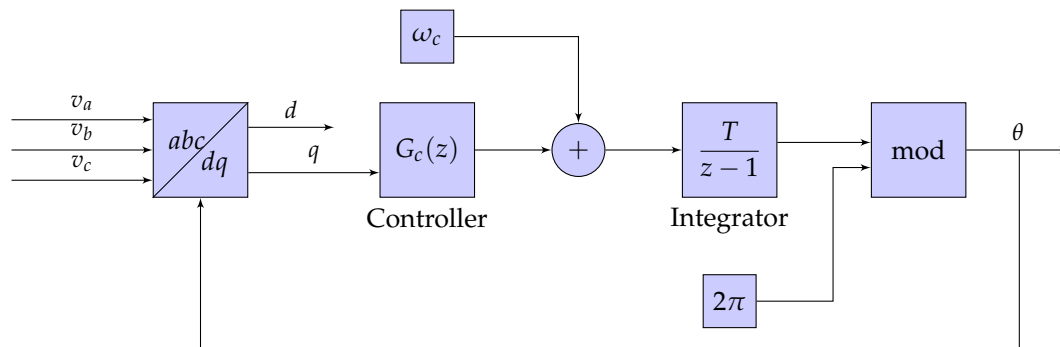


## DIGITAL CONTROL OF POWER ELECTRONICS

## Three Phase PLL Part 3



```

1 clear
2
3 Vg = 170 % 1
4 zeta = 0.7
5 wn= 2 * pi * 100 %158.6859
6 ki = wn^2/Vg
7 kp = 2*zeta*wn/Vg
8
9 s=tf('s')
10 opts = bodeoptions('cstprefs');
11 opts.FreqUnits = 'Hz';
12 gc = ki/s + kp
13 gp = Vg/s
14 gol = gc*gp
15 gcl = minreal(gol/(1+gol))
16
17 figure
18 bode(gol,gcl,opts)
19 grid on
20 %matlab2tikz('fig_3p_pll_bode1.tex')
21
22 %convert controller to digital
23 Ts = 1/10e3
24 Z=tf('z',Ts)
25 sback = ((Z-1)/(Z*Ts))
26 gc_dig_backward = ki/sback + kp
27 gc_dig_zoh = c2d(gc,1/10e3,'zoh')
28 gc_dig_tustin = c2d(gc,1/10e3,'tustin')
29
30 %% calculate coeff for floating point tustin
31 Bcoeff = single(gc_dig_tustin.Numerator{1});
32 Acoeff = single(gc_dig_tustin.Denominator{1});
33 fprintf('float A1 = %f;\n',Acoeff(1))
34 fprintf('float A0 = %f;\n',Acoeff(2))
35 fprintf('float B1 = %f;\n',Bcoeff(1))
36 fprintf('float B0 = %f;\n',Bcoeff(2))

```

Below are the coefficients for backwards euler.

```
1 float A1 = 1.000000;
```

```
2 float A0 = -1.000000;  
3 float B1 = 5.290501;  
4 float B0 = -5.058275;
```

The continuous time controller is shown below

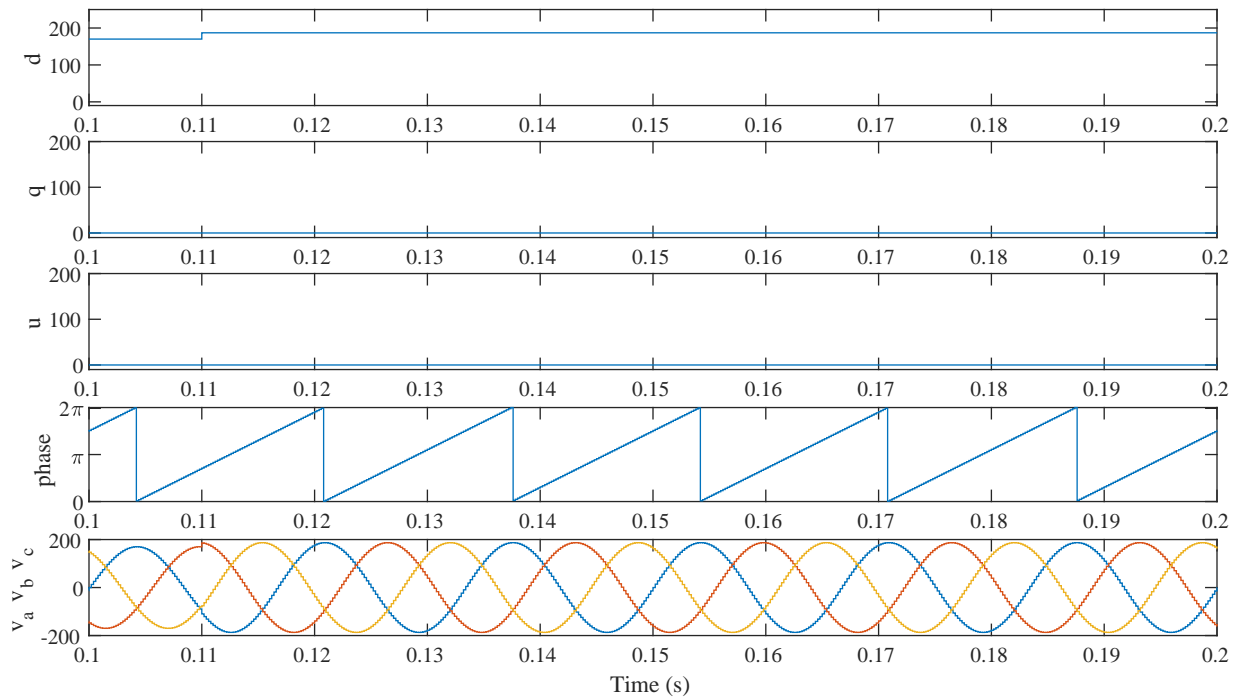
$$G_c(s) = \frac{5.1744s + 2322.3}{s} \quad (1)$$

The controller is converted to a digital controller using the bilinear transformation.

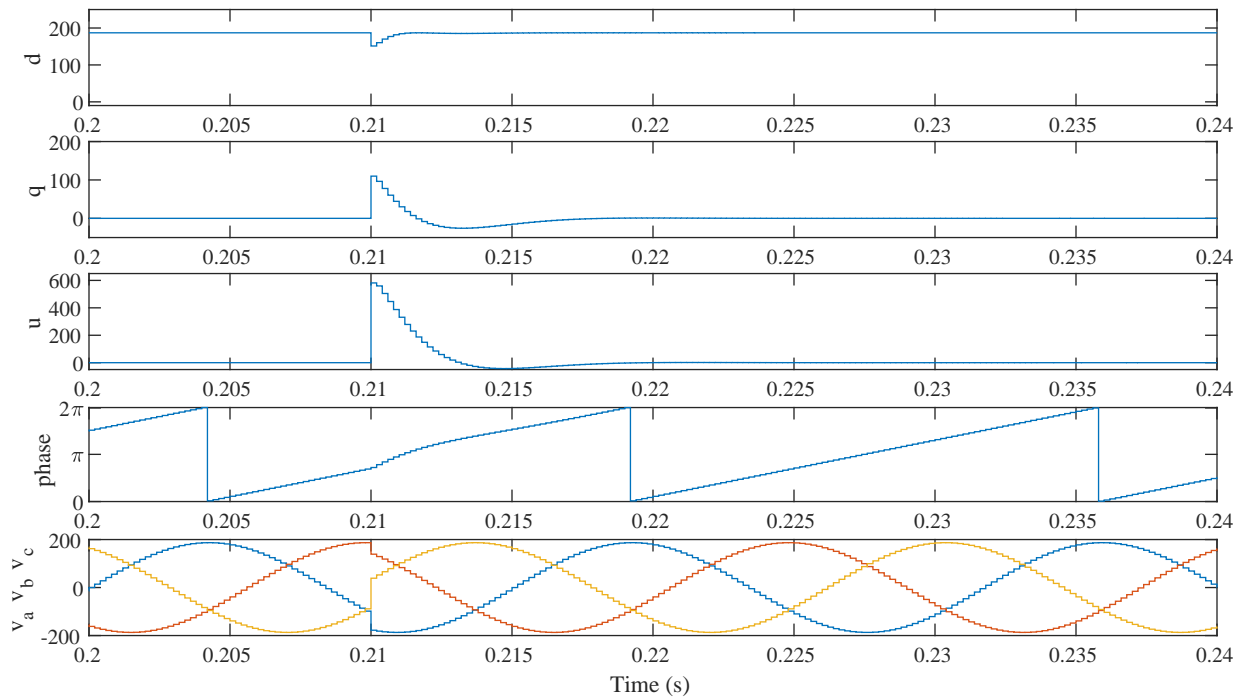
$$G_c(z) = \frac{5.291z - 5.058}{z - 1} \quad (2)$$

There is a pole at 1 and a zero at 0.9561 in the controller.

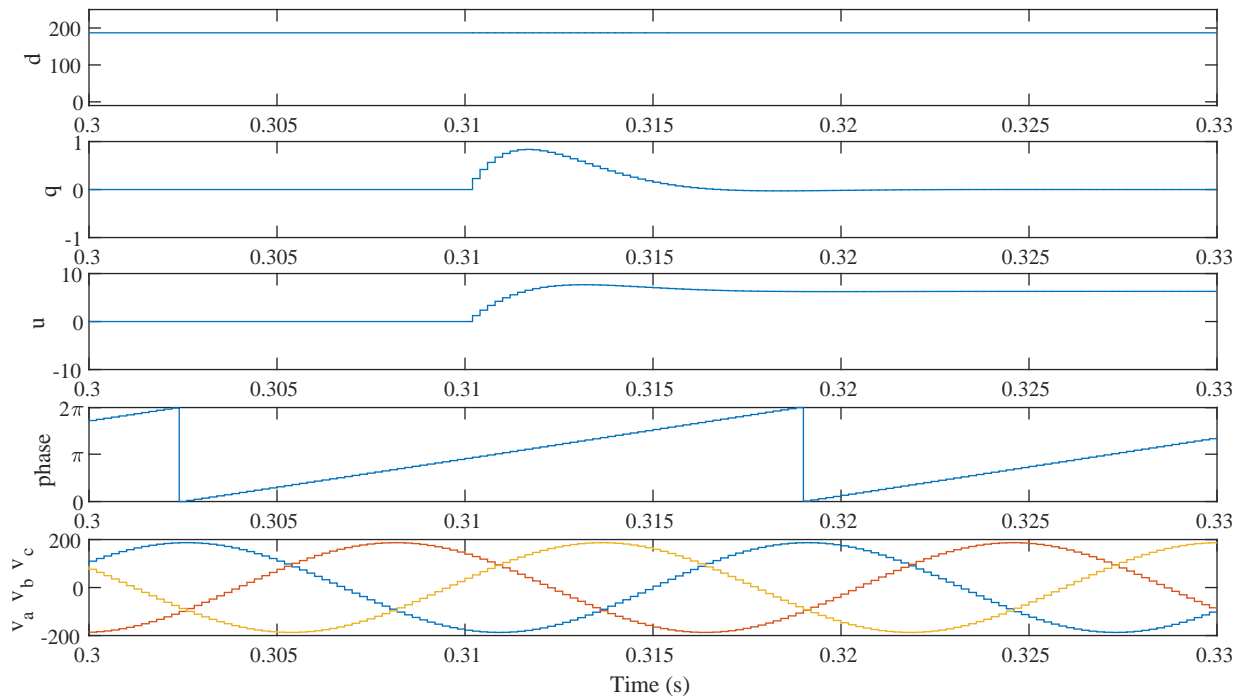
Show below is the d component, q component, control effort u, phase, and the line voltages in response to a voltage step of 17 volts at time 0.11.



Show below is the d component, q component, control effort u, phase, and the line voltages in response to a phase step of 0.6283 radians at time 0.21.



Show below is the d component, q component, control effort u, phase, and the line voltages in response to a frequency step of 1Hz at time 0.31.



Show below is the d component, q component, control effort u, phase, and the line voltages in response to a 10% voltage unbalance step at time 0.35.

