
Table of Contents

| | |
|------------------|---|
| | 1 |
| Question 1 | 1 |
| Question 2 | 5 |
| Question 3 | 7 |

```
% Benjamin Stutzke  
% ENAE 432  
% Homework 10
```

Question 1

```
zeta1 = 0.01;  
zeta2 = 0.005;  
omega1 = 5;  
omega2 = 20;  
rho = 0.05;  
I = 50;  
  
s = tf('s');  
  
n1 = (rho*s^2)*(s^2 + 2*zeta1*omega1*s + omega1^2)^(-1);  
n2 = (rho*s^2)*(s^2 + 2*zeta2*omega2*s + omega2^2)^(-1);  
  
G = 1/((I*s^2)*(1-(n1+n2)))  
zpk(G)  
  
figure(1);  
bode(G);  
title("Question 1: Bode Diagram of G - Benjamin Stutzke");  
  
G0 = 1/(I*s^2)  
  
figure(2);  
bode(G0);  
title("Question 1: Bode of G_0 - Benjamin Stutzke");  
  
K = 1;  
beta = 5.83;  
tau = 0.828;  
  
H0 = beta*tau*s+1 / (tau*s + 1);  
  
K = 5.61;  
H = H0 * K;  
  
L0 = minreal(G0*H0);  
L = minreal(G0 * H);
```

```
figure(3);
bode(L)
title("Question 1: Bode of L with simple model - Benjamin Stutzke");
```

```
T = minreal(L/(L+1));
figure(4);
step(T)
title("Question 1: Step of T with simple model - Benjamin Stutzke");
```

$G =$

$$\frac{s^4 + 0.3 s^3 + 425 s^2 + 45 s + 10000}{45 s^6 + 14.25 s^5 + 2.019e04 s^4 + 2250 s^3 + 500000 s^2}$$

Continuous-time transfer function.

$ans =$

$$\frac{0.022222 (s^2 + 0.1s + 25) (s^2 + 0.2s + 400)}{s^2 (s^2 + 0.1052s + 26.31) (s^2 + 0.2114s + 422.3)}$$

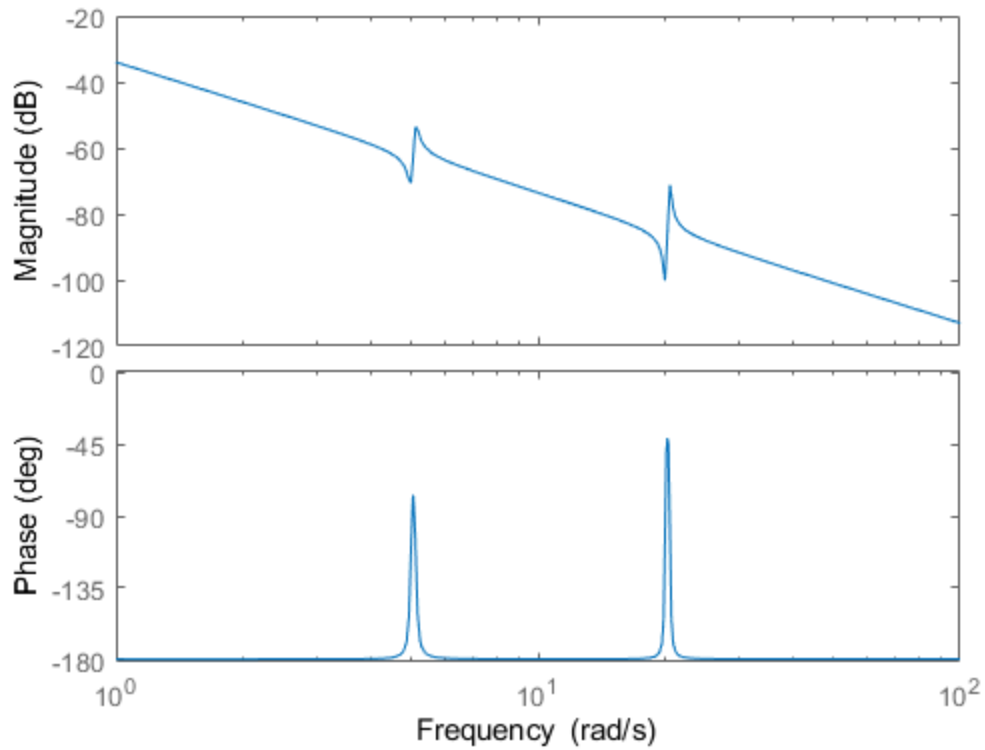
Continuous-time zero/pole/gain model.

$G0 =$

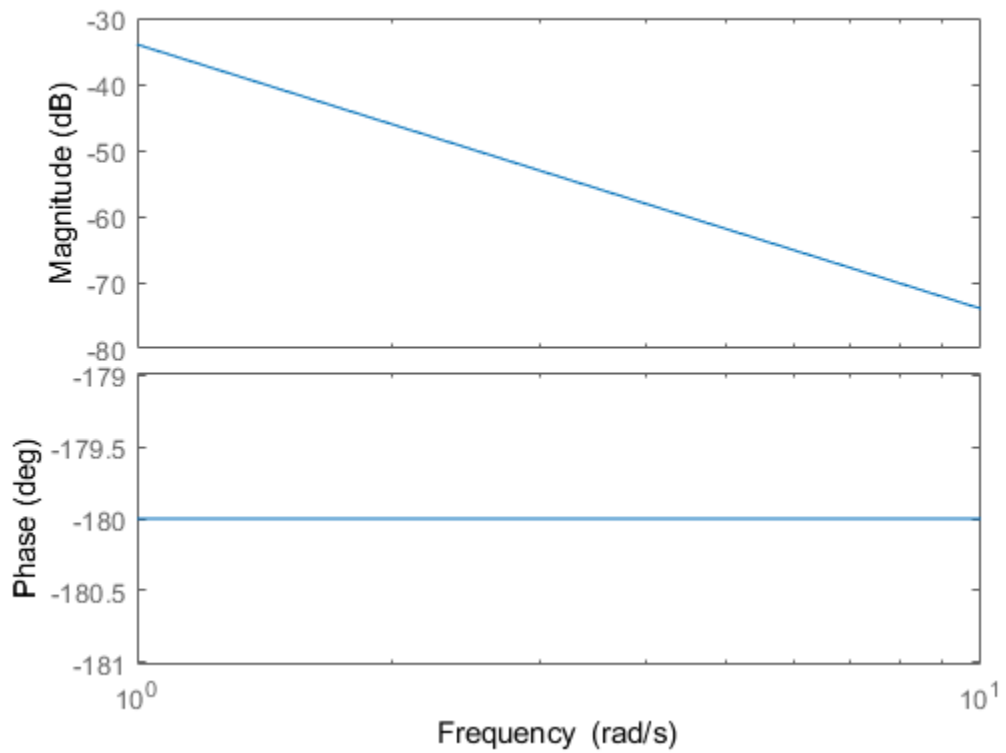
$$\frac{1}{50 s^2}$$

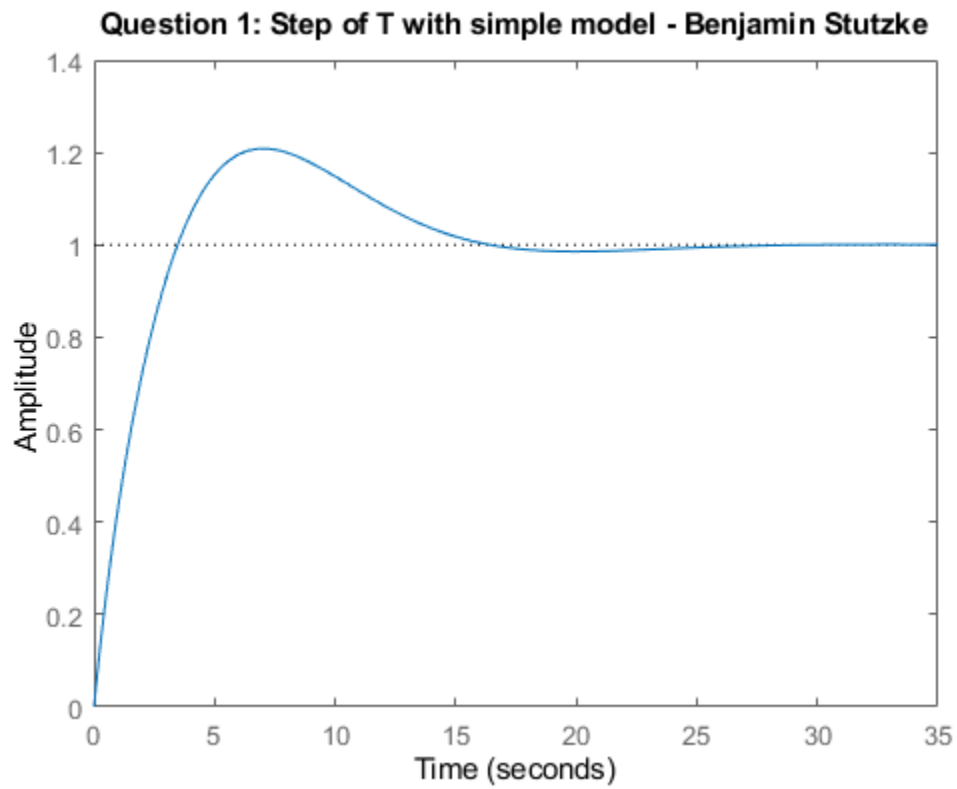
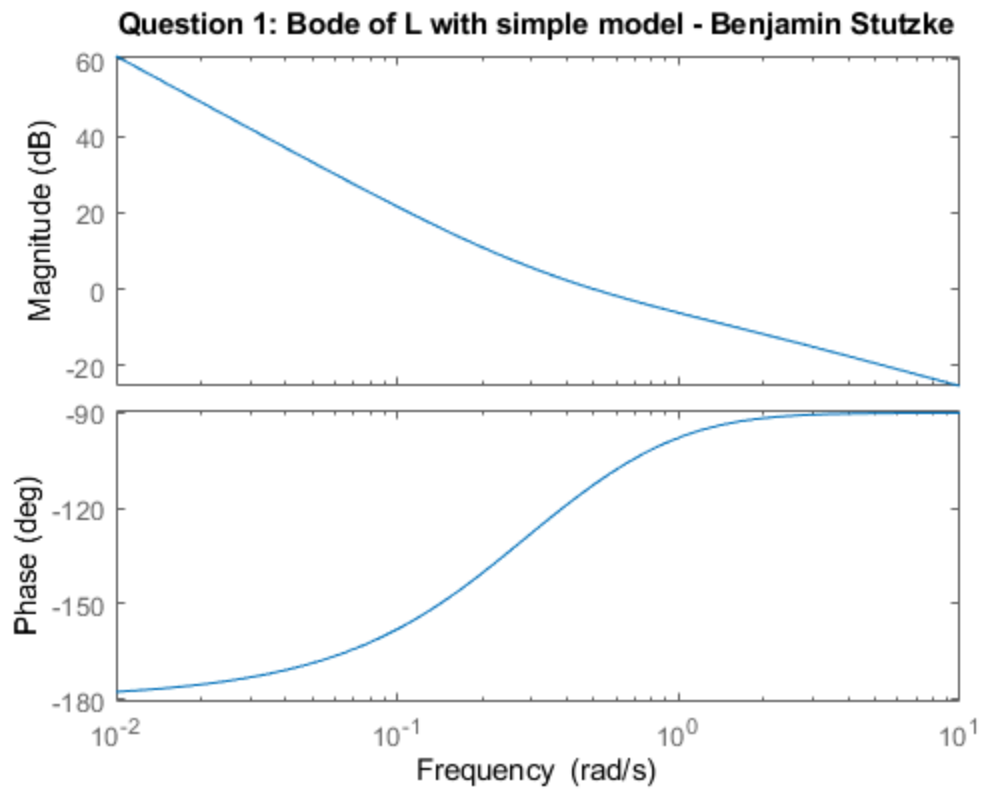
Continuous-time transfer function.

Question 1: Bode Diagram of G - Benjamin Stutzke



Question 1: Bode of G_0 - Benjamin Stutzke





Question 2

```
L_actual = minreal(H*G);
figure(5);
bode(L)
title("Question 2: Bode of L with real model - Benjamin Stutzke");

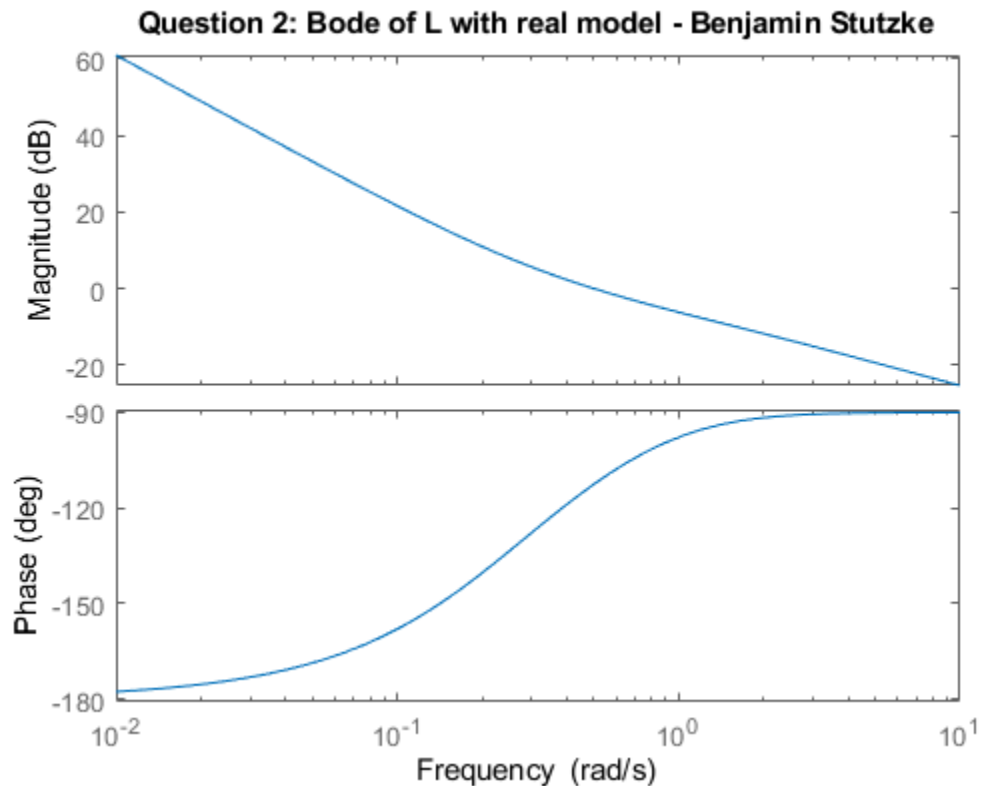
T_actual = minreal(L/(1+L));
figure(6);
step(T_actual, T);
legend("T", "T_0");
title("Question 2: Step comparison - Benjamin Stutzke");

delta = n1 + n2 / (1-n1-n2);

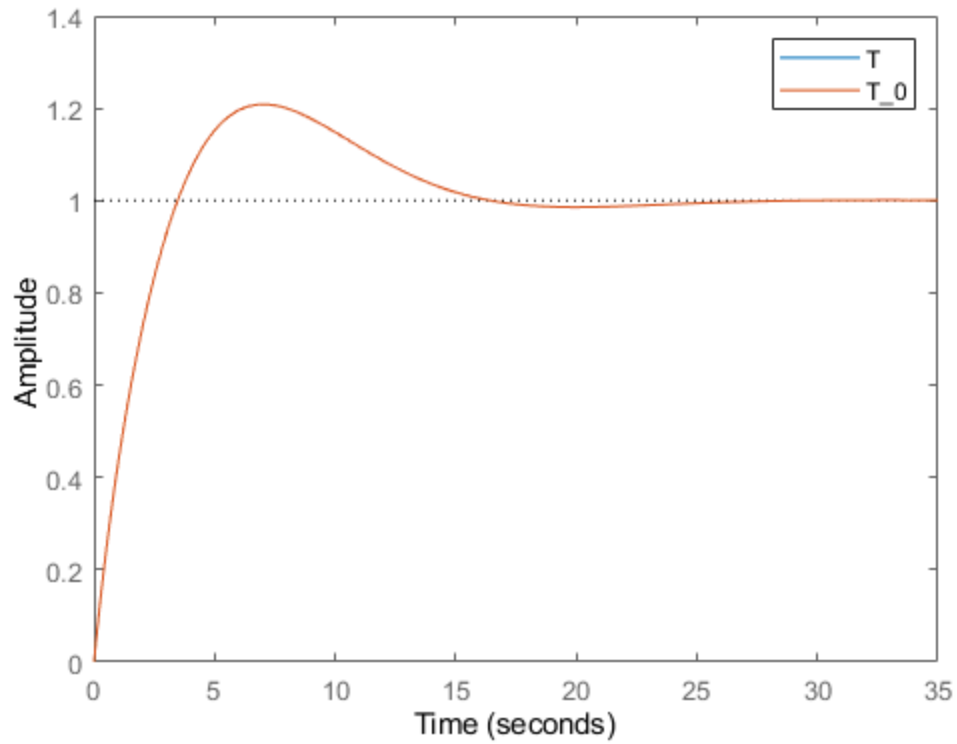
[Tmag, Tphase, Twout] = bode(T);

[invDmag, invDphase, invDwout] = bode(1/delta);

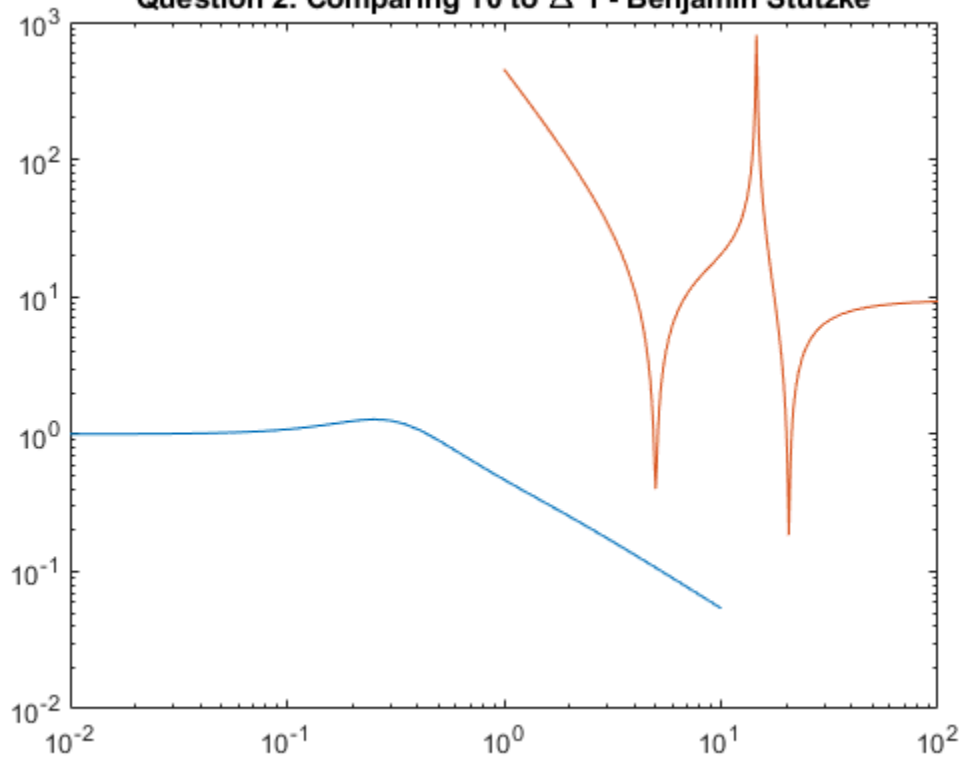
figure(7);
loglog(Twout, Tmag(:, :))
hold on
loglog(invDwout, invDmag(:, :))
title("Question 2: Comparing T0 to \Delta^{-1} - Benjamin Stutzke");
```



Question 2: Step comparison - Benjamin Stutzke



Question 2: Comparing T_0 to Δ^{-1} - Benjamin Stutzke



Question 3

```
s = tf('s');
K = 1;

L0 = 5/(s*(s+5)^3);

w = 0.1;
error = 0.0001;
step = 0.001;
breakpoint = 10000;

w_arr = zeros(1, breakpoint);
r_arr = zeros(1, breakpoint);

counter = 1;
while 1
    s = -1 + w*1i;
    ang = angle(evalfr(L0, s));

    r = rem(ang, pi);
    diff = abs(r) - pi;
    if diff < error && diff > -error
        break;
    end

    w_arr(counter) = w;
    r_arr(counter) = r;

    if counter == breakpoint
        break;
    end

    counter = counter + 1;
    w = w + step;
end
disp(w);

1.2060
```

Published with MATLAB® R2022b