

Contents

■ Functions

```
clear all; close all;
% Define the transfer functions:
H_a(1) = zpk([], [-3], 10);           %a)
H_a(2) = zpk([-70], [-20], 0.2);      %b)
H_a(3) = zpk([0], [-7], 2);           %c)
H_a(4) = zpk([], [0 -7], 20);          %d)
H_a(5) = zpk([], [0 -1/7], 5/7);       %e)
H_a(6) = zpk([], [-1 -10], 75);        %f)
H_a(7) = zpk([-2], [-1/3 -1/2], 2/6); %g)
H_a(8) = zpk([-1/10], [-1/3 -1/2], 2*10/6); %h)
H_a(9) = zpk([-2], [-5, -10], 20);     %i)

for id = 1:9
    H = H_a(id)
    wmin = 1e-3;
    wmax = 1e3;

    wma = calcphase(H, wmin, wmax);

    plot_phase(H, wma);
end
```

H =

10

(s+3)

Continuous-time zero/pole/gain model.

Functions

```
function plot_phase(H, wma)
    [mag, pha, wout] = bode(H, {min(wma(:,1)), max(wma(:,1))});
    pha = squeeze(pha);
    figure
    semilogx(wout, pha, "b");
    hold on
    for i = 1:length(wma)
        semilogx(wma(i,1), wma(i,2), 'ro', 'LineWidth', 2)
    end
    semilogx(wma(:,1), wma(:,2), 'r-', 'LineWidth', 2);
    hold off;
    legend("Bode()", "Approximated")
    title("Phase characteristics:")
    grid; shg;
end
```

```

function wma_out = calcphase(H,wmin,wmax)
    z = abs(cell2mat(H.Z));
    p = abs(cell2mat(H.P));
    k = k_cal(H,z,p);

    wma = wma_init_gen(H,wmin,wmax);

    wma_z = wma;
    w_z = wma;
    wma_p = wma;
    w_p = wma;
    % Calc for zeros
    if isempty(z)
        % calc for konst
        if k < 0
            wma_z(:,2) = wma_z(:,2)*pi;
        else
            wma_z = wma_z;
        end
    else
        % Calc for z in origin
        for l=1:length(z)
            if isempty(find(~z))
                index_start = find(wma_z(:,1) == min(z)*0.1);
                %the larges zero*10s position in wma
                index_finish = find(wma_z(:,1) == max(z)*10);
                wma_z(index_finish,2) = 90*length(z);

                i = index_finish-1;
                while i >= index_start
                    wma_z(i,2) = wma_z(i+1,2)-45*length(z)*(log10(wma_z(i+1,1)/wma_z(i,1)));
                    i = i - 1;
                end

                wma_z(index_finish:end,2) = wma_z(index_finish,2);

            else
                % Calc for z in origin
                wma_z(:,2) = wma_z(:,2)+90*length(find(~z));
            end
            w_z(:,2) =w_z(:,2) + wma_z(:,2);

        end
    end

    % Calc for poles:
    if isempty(p)
        % calc for konst
        if k < 0
            wma_p(:,2) = wma_p(:,2)*pi;
        else
            wma_p = wma_p;
        end
    else
        % Calc for p in origin
        for l = 1:length(p)
            if find(p(l))
                index_start = find(wma_p(:,1) == min(p)*0.1);
            end
        end
    end
end

```

```

        %the largest zero*10s position in wma
        index_finish = find(wma_p(:,1) == max(p)*10);
        wma_p(index_finish,2) = -90*length(p);

        i = index_finish-1;
        while i >= index_start+1
            wma_p(i,2) = wma_p(i+1,2)+45*length(p)*(log10(wma_p(i+1,1)/wma_p(i,1)));
            i = i - 1;
        end

        wma_p(index_finish:end,2) = wma_p(index_finish,2);

    else
        % Calc for z in origin
        wma_p(:,2) = wma_p(:,2)-90*length(find(~p));
    end

end

end

wma_out = [wma_z(:,1), wma_z(:,2) + wma_p(:,2)];
end
function wma_init = wma_init_gen(H, wmin, wmax)
    z = abs(cell2mat(H.Z));
    p = abs(cell2mat(H.P));

    aux = [0.1 1 10]';
    wma = [wmin; wmax];

    if ~isempty(z)
        wma = [wma; reshape(z.*aux,[],1)];
    end
    if ~isempty(p)
        for i = 1:length(p)
            wma = [wma; reshape(p(i).*aux,[],1)];
        end
    end
    wma = sortrows(wma);
    if ~isempty(max(find(~wma)))
        wma = wma(max(find(~wma)) + 1:end);
    end
    % due to some computational deviance we need to give a tolerance
    % to get unique value
    wma = uniquetol(wma,1e-15);

    wma_init =[wma, zeros(length(wma),1)];
end
function k = k_cal(H,z,p)
    % We check for zeros in zero:
    if length(z) ~= 0
        for i = 1:length(z)
            if z(i) == 0
                z_k(i) = 1;
            else
                z_k(i) = z(i);
            end
        end
    end
end

```

```

        end
    else
        z_k = 1;
    end

    % We check for poles in zero
    if length(p) ~= 0
        for i = 1:length(p)
            if p(i) == 0
                p_k(i) = 1;
            else
                p_k(i) = p(i);
            end
        end
    else
        p_k = 1;
    end

    % We calculater the gain:
    k = H.K*prod(z_k)/prod(p_k);

end

```

H =

$$\frac{0.2 (s+70)}{(s+20)}$$

Continuous-time zero/pole/gain model.

H =

$$\frac{s^2}{(s+7)}$$

Continuous-time zero/pole/gain model.

H =

$$\frac{20}{s (s+7)}$$

Continuous-time zero/pole/gain model.

H =

$$\frac{0.71429}{s (s+0.1429)}$$

Continuous-time zero/pole/gain model.

H =

$$\frac{75}{(s+1)(s+10)}$$

Continuous-time zero/pole/gain model.

H =

$$\frac{0.33333 (s+2)}{(s+0.3333) (s+0.5)}$$

Continuous-time zero/pole/gain model.

H =

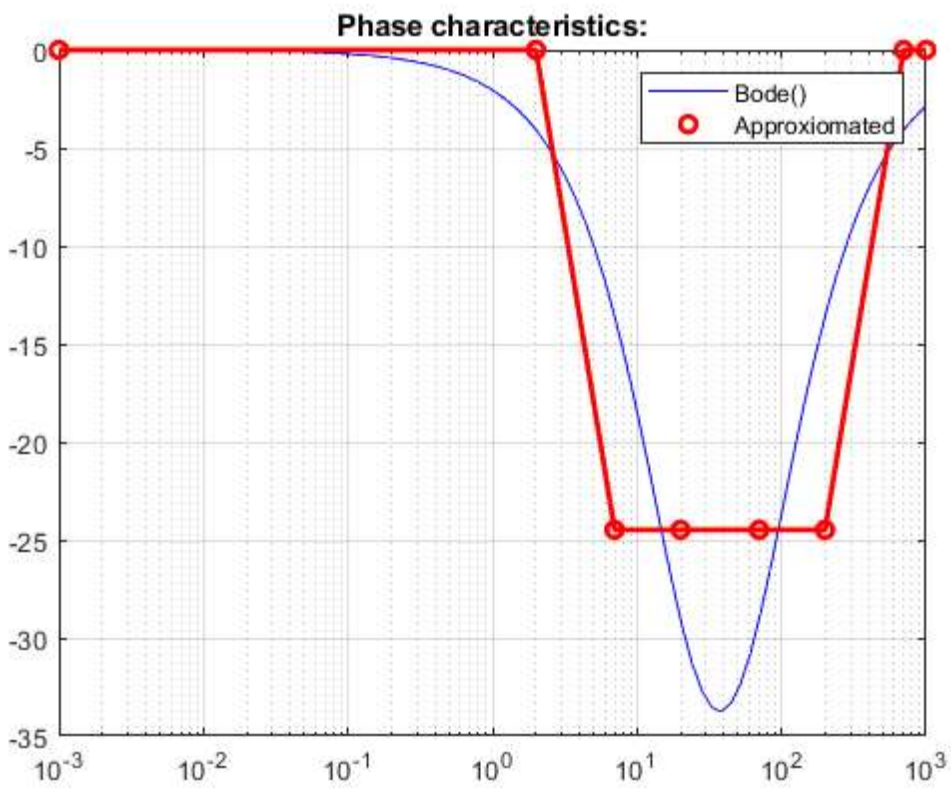
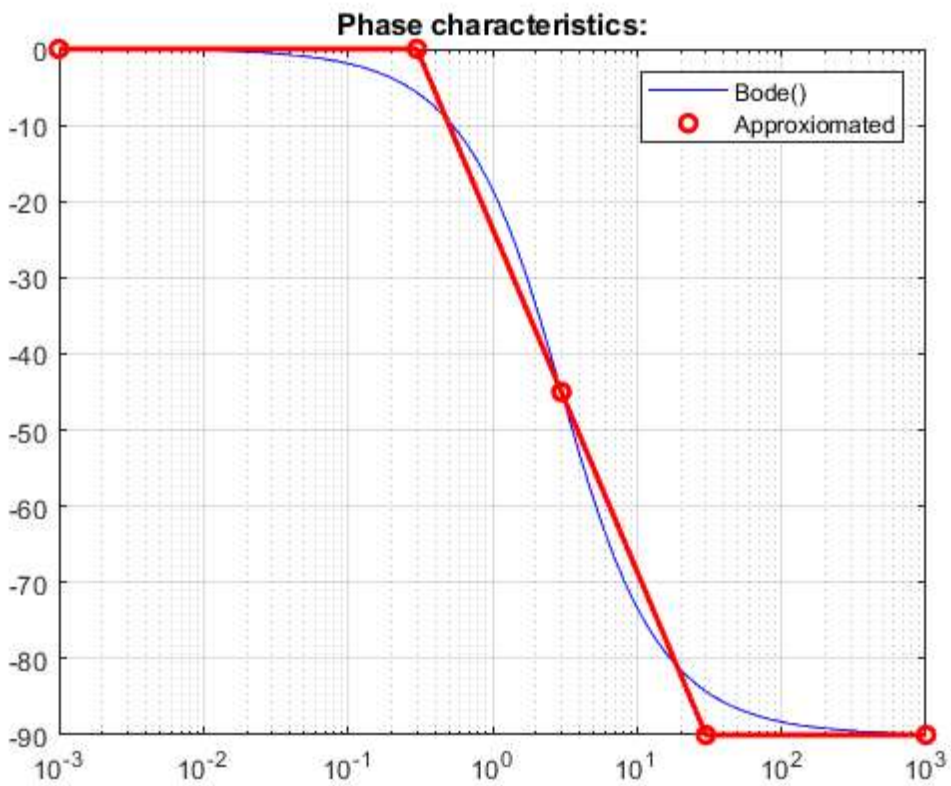
$$\frac{3.3333 (s+0.1)}{(s+0.3333) (s+0.5)}$$

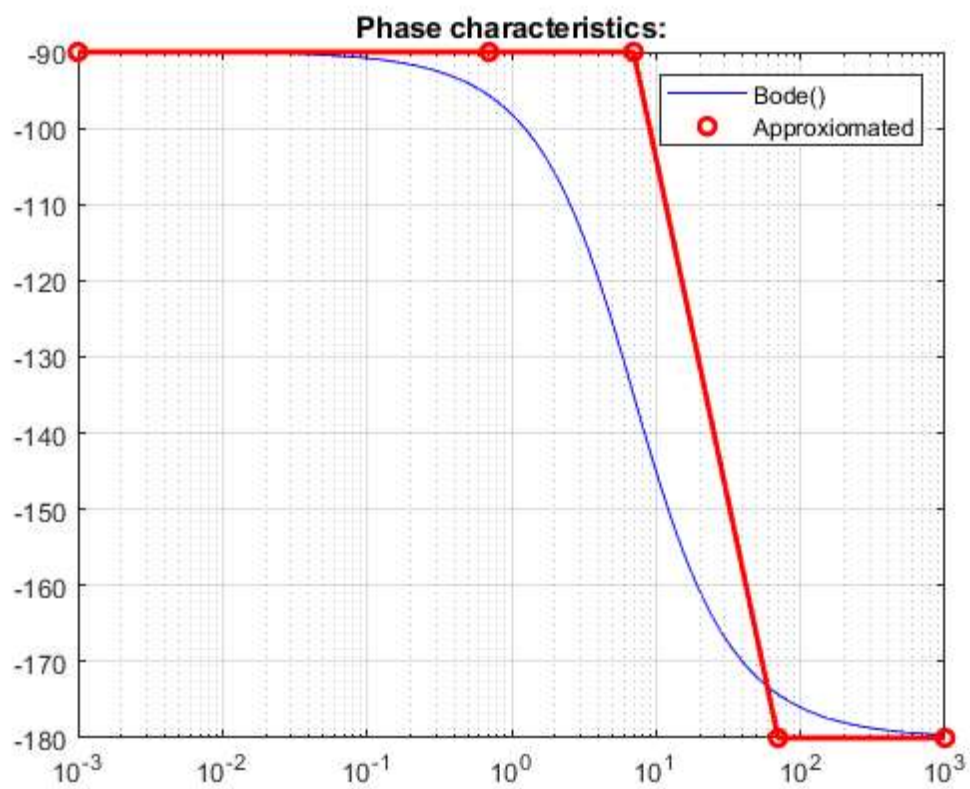
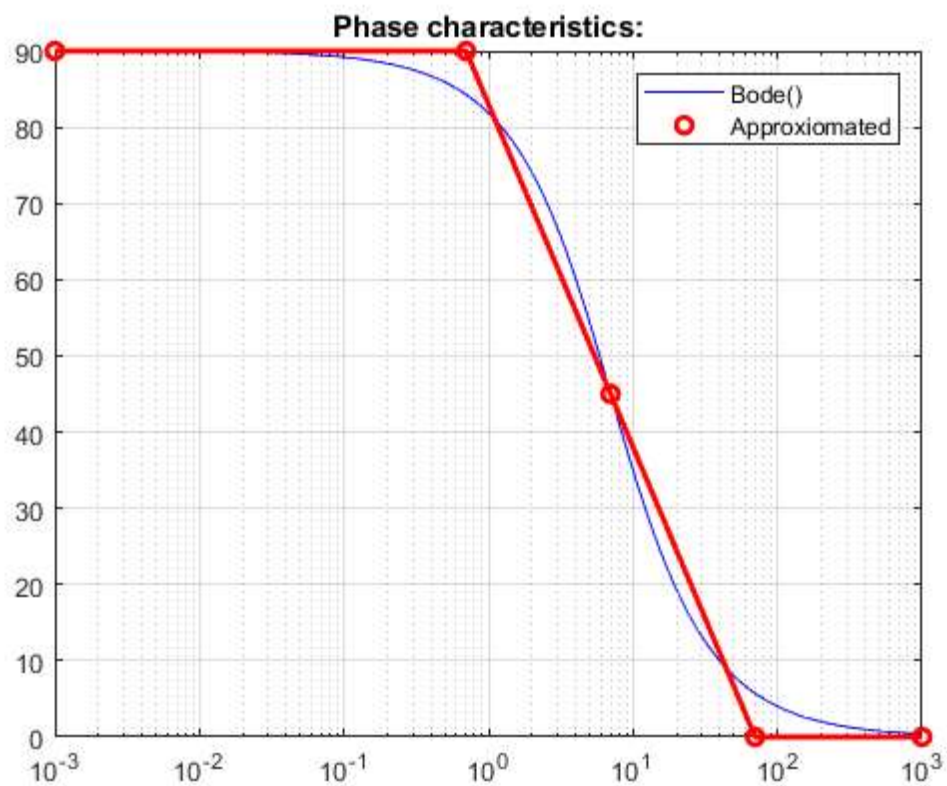
Continuous-time zero/pole/gain model.

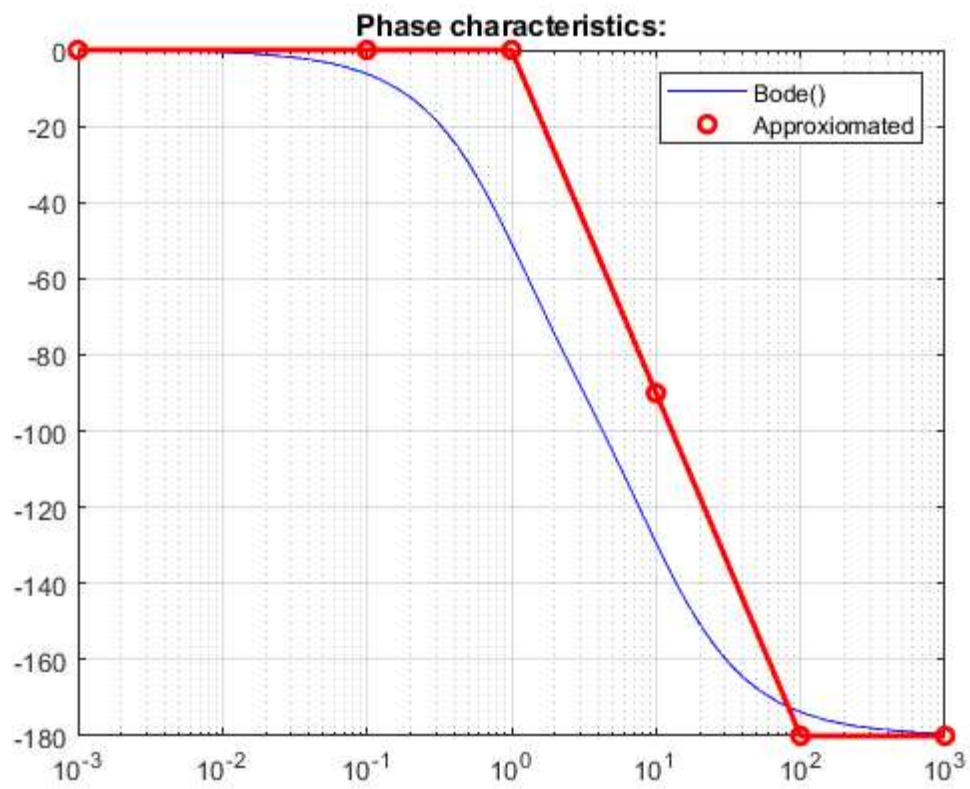
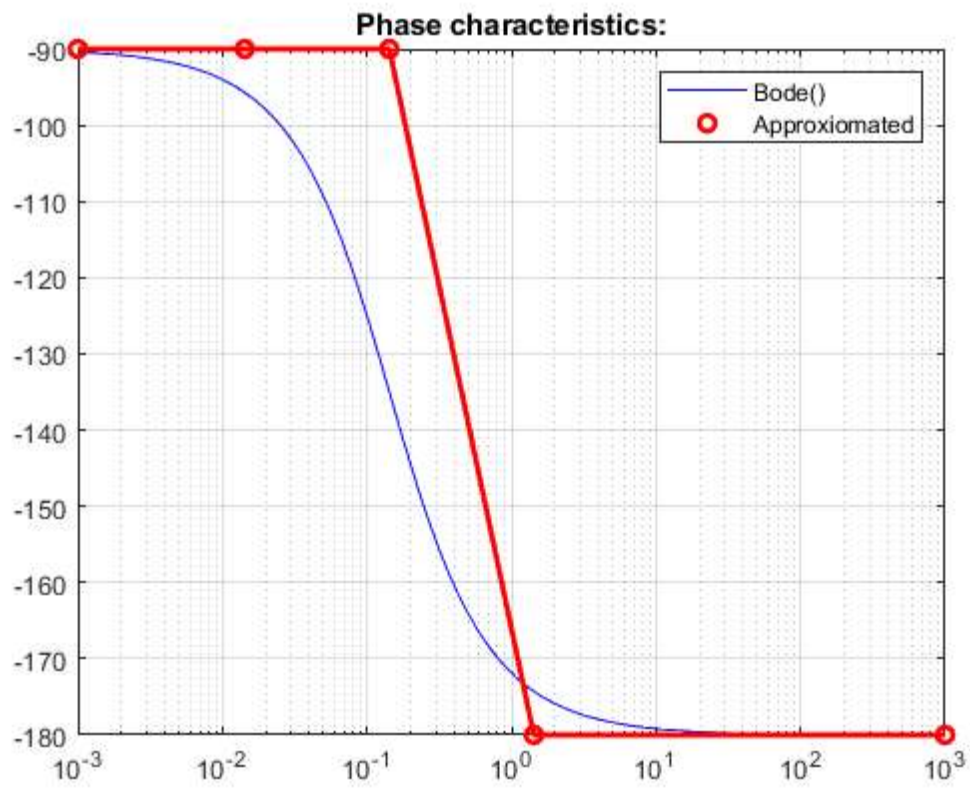
H =

$$\frac{20 (s+2)}{(s+5) (s+10)}$$

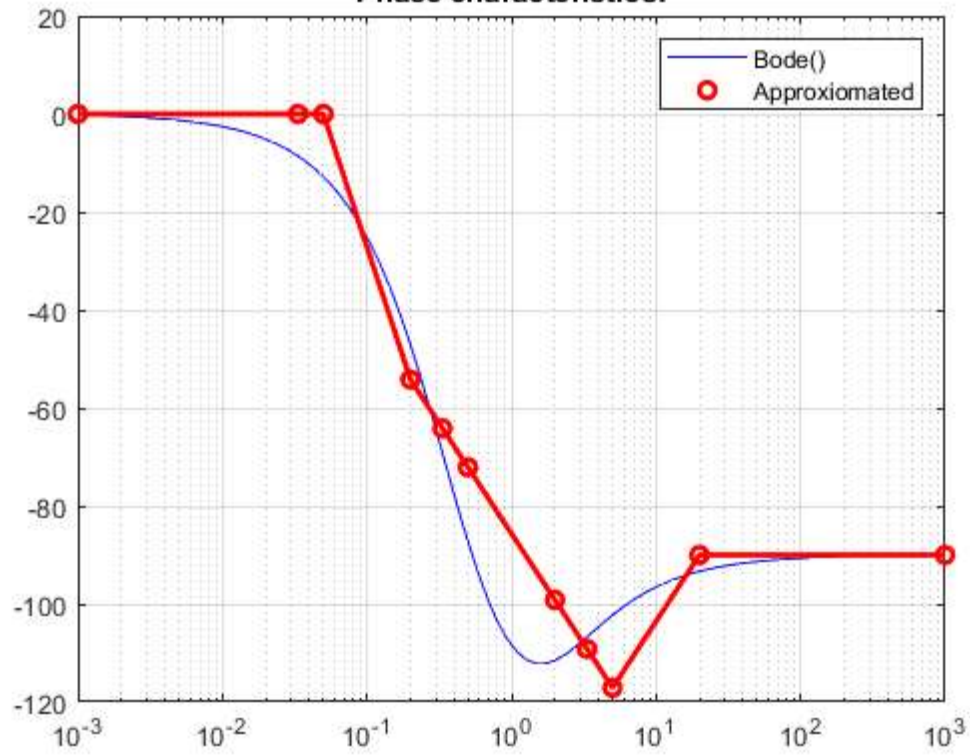
Continuous-time zero/pole/gain model.







Phase characteristics:



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