Sprawozdanie STP
Projekt nr.2
Zadanie 9
Suplement
Kod oraz wykresy

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1. Kod Matlab Files :

- Zadanie 1

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 1 - wyznaczenie modelu oraz symulacja
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
function [systems] = P1()
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Inicjalizacja - okres próbkowania i maksymalne testowane opoznienie
Ts = 1; maxTau = 20;
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Pobranie danych z pliku
[u,y]=getDataFromFile("dane9.txt");
% Wyliczenie modeli wej¶ciowych w oparciu o dane
modelData = iddata(y,u,Ts);
systems = idtf(zeros(1,1,maxTau));
% Wyznaczenie modeli o opoznieniu do maxTau
for j = 0:maxTau
    tau = j;
    delay = tau + 1;
    % Podajemy licznik i mianownik tak aby otrzymaæ model z dwoma
    % skladnikami w mianowniku i liczniku
    N = [zeros(delay ,1)' NaN NaN];
    D = [ 1 NaN NaN];

    model = idtf(N,D,Ts);
    % Oznaczamy warto¶ci licznika do dwóch ostatnich jako
        niezmienialne
    % zera na potrzeby tfest
    for i = 1:delay
        model.Structure.num.Free(i) = false;
    end
    % Wyliczamy po kolei nasze systemy
    systems(:,:,j+1) = tfest(modelData,model);
end
% Wyznaczenie bledu dla kazdego modelu i narysowanie wykresow
Errors = zeros(1,maxTau+1);
for j = 0:maxTau
   [~,Errors(j+1)]=P1_Draw(systems(:,:,j+1),u,y,j);
end
```

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 1 - funkcja pomocnicza do ryswoania wykresow
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
function [f,E] = P1_Draw(TransferFunction,u,y,tau)
% 'Czas' na potrzeby rysunku
T_sim = 0:999;
% Oblicz blad
y1=lsim(TransferFunction,u,T_sim);
E = getSquareError(y1,y);
% Ustal tytul
titleString = sprintf('%s %d %s %d','Porownanie modelu i danych dla tau = ', tau,' blad E = ',E);
% Stworz obiekt na rysunki bez wyswietlanie
f = figure('Name', titleString,'Visible','Off');
set(gcf, 'Position', [100, 100, 800, 600])
hold on;
% Przeprowadz symulacje
lsim(TransferFunction,u,T_sim);
plot(y);
% Dodaj legende i opis
legend('Model','Dane');
xlabel('Czas');
title(titleString);

hold off;
saveas(f,strcat('ModelsP1/modelTau',num2str(tau),'.png'));
```

- Zadanie 2

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 2 - wyznaczenie odpowiedzi skokowej
% Model z tau = 3 daje najmniejszy sredni blad
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
function [] = P2()
systems = P1();
sys = systems(:,:,4);
%Odpowiedz skokowa
s = step(sys)
%Wzmocnienie statyczne
K = dcgain(sys);
% K = 3,7432
```

- Zadanie 3

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 4 -symulacja regulatora PID
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%

%inicjalizacja
kk = 1000; % czas symylacji
y_zad = zeros(1,kk); % wartosc zadana w funkcji czasu
y_zad(13:kk) = 1; % skok wartosci zadanej do 1 w k = 13
y=zeros(1,kk);
u=zeros(1,kk);
e=zeros(1,kk);

%Parametry naszego modelu
a1=-1.664; a0=0.692; b1=0.0535; b0=0.05131; T= 0.5;
%Procedura ZN
K_kr = 1.36; T_kr =20 ;
%Wyliczenie parametrów PID
K = 0.6*K_kr; Ti = 0.5*T_kr; Td = 0.12*T_kr;
%The controller parameters are proportional gain K, integral time Ti, and derivative time Td
% Wartosci PID dyskretnego policzone z ww.
r1 = K*(1 + T/(2*Ti) + Td/T  );
r2 = K*(T/(2*Ti) - 2*Td/T - 1);
r3 = K*Td/T;

%warunki poczatkowe
u(1:4)=0; y(1:4)=0;
yzad(1:49)=0; yzad(50:kk)=1;
e(1:4)=0;
```

```
for k=6:kk
    y(k)=b1*u(k-3)+b0*u(k-4)-a1*y(k-1)-a0*y(k-2);
    e(k) = y_zad(k) - y(k);
    u(k) = u(k-1) + r1*e(k) + r2*e(k) +r3*e(k);
end
f = figure();
stairs(y); hold on; stairs(yzad,':');
title('Symulacja PID' ); xlabel('k'); ylabel('y');
title = sprintf(strrep(['ModelsP3/PID/P4-2_r1_' num2str(r1) 'r2_' num2str(r2) 'r3_' num2str(r3)],'.',''));
title = strrep(title,'.','_');
print(f, title, '-dpng');
```

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 3 - dobor parametrow metoda Zieglera-Nicholsona, wydrukowanie
% obrazku
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
function [f] = P3_Draw(K_r,y, yzad)
    f = figure('visible','off'); stairs(y); hold on; stairs(yzad,':');
    title(['Procedura Zieglera Nicholsa ' num2str(K_r) ]); xlabel('k'); ylabel('y');
    legend('y_{zad}');
    fileTitle = sprintf(strcat(strrep(['ModelsP3/ZN/P2_K' num2str(K_r) '.png'],'.','')));
    print(f, fileTitle, '-dpng');
```

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 3 - dobor parametrow metoda Zieglera-Nicholsona
% Program w oparciu o algorytm przedstawiony na stronie 90-91 skryptu
% do przedmiotu
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%

%inicjalizacja
a1=-1.664; a0=0.692; b1=0.0535; b0=0.05131;
K_r_Base =0.05;
kk=1000;

for i = 27:0.1:28
    y = zeros(kk,1);
    %warunki poczatkowe
    u(1:4)=0;
    yzad(1:29)=0; yzad(30:kk)=1;
    e(1:4)=0;
    K_r=K_r_Base*i;
    for k=5:kk %glowna petla symulacyjna , k_min = 6 dla zachowania ciaglosci
        %symulacja obiektu
         y(k)=b1*u(k-3)+b0*u(k-4)-a1*y(k-1)-a0*y(k-2);
        %uchyb regulacji
         e(k)=yzad(k)-y(k);
        %sygnal sterujacy regulatora PID
         u(k)=K_r*e(k);
    end

    % drukuj i zapisz wyniki symulacji
    P3_Draw(K_r, y, yzad);
end
```

- Zadanie 4

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 4 symulacja regulatora DMC,  wybrane par. : D - D = 50
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
clear;
% Inicjalizacja
% Model
systems = P1();
sys = systems(:,:,4);

value = 'D';
lambda = 1;
```

```
Dmax = 200;
Nu = 20;
N=100;
kk = 500;
step = 5;
Ju = zeros(Dmax/step,2);
Jy = zeros(Dmax/step,2);
i=1;
for D = Dmax:-step:5
     [y,y_zad,u,Jy(i,1),Ju(i,1)] = DMCnoLimit(sys ,N,Nu,D,lambda,kk);
     Jy(i,2) = D;Ju(i,2) = D;
    DMC_Draw(kk, y,y_zad, u,D,value,'P4');
     i=i+1;
end
DrawJ(Jy,'D','Jy');
DrawJ(Ju,'D','Ju');
```

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 4 symulacja regulatora DMC, wybrane par. : D - D = 50, N = 15,
% Nu = 2, lambda = 3
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
clear;
% Inicjalizacja
% Model
systems = P1();
sys = systems(:,:,4);
a=sys.Denominator;b=sys.Numerator;T= sys.Ts;
value = 'Lambda';
lambdaMax = 100;
D = 50;
Nu = 2;
N = 25;
kk = 500;
Ju = zeros(lambdaMax,2);
Jy = zeros(lambdaMax,2);
i=1;
for lambda = lambdaMax:-1:1
     [y,y_zad,u,Jy(i,1),Ju(i,1)] = DMCnoLimit(sys ,N,Nu,D,lambda,kk);
     Jy(i,2) = lambda;Ju(i,2) = lambda;

    DMC_Draw(kk, y,y_zad, u,lambda,value,'P4');
     i=i+1;
end
DrawJ(Jy,'lambda','Jy');
DrawJ(Ju,'lambda','Ju');
```

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 4 symulacja regulatora DMC,  wybrane par. : D - D = 50, N = 15
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
clear;
% Inicjalizacja
% Model
systems = P1();
sys = systems(:,:,4);

value = 'N';
lambda = 1;
D = 50;
Nu = 20;
Nmax=100;
kk = 500;
step = 5;
Ju = zeros(Nmax/step,2);
Jy = zeros(Nmax/step,2);
i=1;
for N = Nmax:-step:5
     [y,y_zad,u,Jy(i,1),Ju(i,1)] = DMCnoLimit(sys ,N,Nu,D,lambda,kk);
     Jy(i,2) = N;Ju(i,2) = N;
    DMC_Draw(kk, y,y_zad, u,N,value,'P4');
     i=i+1;
end
DrawJ(Jy,'N','Jy');
DrawJ(Ju,'N','Ju');
```

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
```

```
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 4 symulacja regulatora DMC, wybrane par. : D - D = 50, N = 15,
% Nu = 2
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
clear;
% Model
systems = P1();
sys = systems(:,:,4);
% Wartosc oceniana
value = 'Nu';

lambda = 1;
D = 50;
Numax = 20;
N=25;
kk = 500;
Ju = zeros(Numax,2);
Jy = zeros(Numax,2);
i=1;
for Nu = Numax:-1:1
    [y,y_zad,u,Jy(i,1),Ju(i,1)] = DMCnoLimit(sys ,N,Nu,D,lambda,kk);
    Jy(i,2) = Nu;Ju(i,2) = Nu;
    DMC_Draw(kk, y,y_zad, u,Nu,value,'P4');
    i=i+1;
end
DrawJ(Jy,'Nu','Jy');
DrawJ(Ju,'Nu','Ju');
```

- Zadanie 5

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 5 symulacja regulatora DMC z zakloceniem, wybrane par. : D = 50, N = 15,
% Nu = 2, lambda = 3
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% % Model
systems = P1();
sys = systems(:,:,4);
a=sys.Denominator;b=sys.Numerator;T= sys.Ts;
value = 'Disturbance';
lambda = 2;
D = 50;
Nu = 2;
N = 25;
a=sys.Denominator;b=sys.Numerator;T= sys.Ts;
skok = step(sys,1:T:N+Nu+D);

for disturbance_amp = 0.1:0.1:5
    % Wyzerowanie do kolejnych obliczen
    y_zad = zeros(1,kk);
    disturbance = zeros(1,kk);
    disturbance(kk/2:end) = disturbance_amp;
    y=zeros(1,kk);
    u=zeros(1,kk);
    du = zeros(1,kk);

    % Obliczanie macierzy predykcji
    M_P = zeros(N,D-1);

    for j=1:(D-1)
        for i=1:N
            M_P(i,j) = skok(i+j) - skok(j);
        end
    end

    % Wyznaczenie macierzy dynamicznej
    M_D = zeros(N, Nu);
    for i=1:Nu
        for j=1:N
            if j >= i
                M_D(j+i-1,i) = skok(j);
            else
                M_D(j,i) = 0;
            end
        end
    end



    % Wyznaczenie macierzy K
```

```
    K = (M_D'*M_D + lambda*eye(Nu))^-1 * M_D';

    K1 = K(1,1:N);
    ke = sum(K1);

    for k=D:kk
        y(k)=b(2)*u(k-3)+b(3)*u(k-4)-a(2)*y(k-1)-a(3)*y(k-2) + disturbance(k);
        swob = 0;
        for j=1:(D-1)
            ku = K1*M_P(:,j);
            swob = swob + ku*du(k-j);
        end
        du(k) = ke*(y_zad(k) - y(k)) - swob;
        u(k) = u(k-1) + du(k);
    end
    DMC_Draw(kk, y,y_zad, u,disturbance_amp,value,"P4");
end
```

- Zadanie 6

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 6 symulacja regulatora DMC, wybrane par. : D - D = 50, N = 15,
% Nu = 2
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Model
systems = P1();
sys = systems(:,:,4);
a=sys.Denominator;b=sys.Numerator;T= sys.Ts;
kk=500;
lambda = 2;
D = 50;
Nu = 2;
N = 25;
skok = step(sys,1:T:N+Nu+D);
dumax=1;
umax=0.3;
for ulimit = 0.2:0.01:umax
    % Wyzerowanie do kolejnych obliczen
    y_zad = zeros(1,kk);
    y_zad(D:kk) = 1;
    y=zeros(1,kk);
    u=zeros(1,kk);
    du = zeros(1,kk);

    % Obliczanie macierzy predykcji
    M_P = zeros(N,D-1);

    for j=1:(D-1)
        for i=1:N
            M_P(i,j) = skok(i+j) - skok(j);
        end
    end

    % Wyznaczenie macierzy dynamicznej
    M_D = zeros(N, Nu);
    for i=1:Nu
        for j=1:N
            if j >= i
                M_D(j+i-1,i) = skok(j);
            else
                M_D(j,i) = 0;
            end
        end
    end



    % Wyznaczenie macierzy K

    K = (M_D'*M_D + lambda*eye(Nu))^-1 * M_D';

    K1 = K(1,1:N);
    ke = sum(K1);

    for k=D:kk
        y(k)=b(2)*u(k-3)+b(3)*u(k-4)-a(2)*y(k-1)-a(3)*y(k-2);
        swob = 0;
        for j=1:(D-1)
```

```
            ku = K1*M_P(:,j);
            swob = swob + ku*du(k-j);
        end
        du(k) = ke*(y_zad(k) - y(k)) - swob;
        u(k) = u(k-1) + du(k);
        if(u(k) > ulimit)
            u(k) = ulimit;
        end
        if(u(k) < -ulimit)
            u(k) = -ulimit;
        end
    end
    DMC_Draw(kk, y,y_zad, u,ulimit,"ulimit","P6");
end
```

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
    %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 6 symulacja regulatora DMC, wybrane par. : D - D = 50, N = 15,
% Nu = 2
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
    %%%%%
% Model
systems = P1();
sys = systems(:,:,4);
a=sys.Denominator;b=sys.Numerator;T= sys.Ts;
kk=500;
lambda = 2;
D = 50;
Nu = 2;
N = 25;
skok = step(sys,1:T:N+Nu+D);
dumax=1;
umax=1;
for ulimit = 0:0.01:dumax
    % Wyzerowanie do kolejnych obliczen
    y_zad = zeros(1,kk);
    y_zad(D:kk) = 1;
    y=zeros(1,kk);
    u=zeros(1,kk);
    du = zeros(1,kk);

    % Obliczanie macierzy predykcji
    M_P = zeros(N,D-1);

    for j=1:(D-1)
        for i=1:N
            M_P(i,j) = skok(i+j) - skok(j);
        end
    end

    % Wyznaczenie macierzy dynamicznej
    M_D = zeros(N, Nu);
    for i=1:Nu
        for j=1:N
            if j >= i
                M_D(j+i-1,i) = skok(j);
            else
                M_D(j,i) = 0;
            end
        end
    end



    % Wyznaczenie macierzy K

    K = (M_D'*M_D + lambda*eye(Nu))^-1 * M_D';

    K1 = K(1,1:N);
    ke = sum(K1);

    for k=D:kk
        y(k)=b(2)*u(k-3)+b(3)*u(k-4)-a(2)*y(k-1)-a(3)*y(k-2);
        swob = 0;
        for j=1:(D-1)
            ku = K1*M_P(:,j);
            swob = swob + ku*du(k-j);
        end
        du(k) = ke*(y_zad(k) - y(k)) - swob;
        if(du(k) > ulimit)
            du(k) = ulimit;
        end
        if(du(k) < -ulimit)
```

```
            du(k) = -ulimit;
        end
        u(k) = u(k-1) + du(k);
    end
    DMC_Draw(kk, y,y_zad, u,ulimit,"dulimit","P6");
end
```

```
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Projekt nr. 2 STP - Kajetan Kaczmarek
% Punkt 6 symulacja regulatora DMC, wybrane par. : D - D = 50, N = 15,
% Nu = 2
% Wybrane wartosci : dulimit = 0.27 , dlimit = 0.09
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
%%%  Inicjalizacja
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Model
systems = P1();sys = systems(:,:,4);
% Parametry
a=sys.Denominator;b=sys.Numerator;T= sys.Ts;
kk=500;lambda = 2; D = 50;Nu = 2;N = 25;
% Odpowiedz skokowwa systemu
skok = step(sys,1:T:N+Nu+D);
% Ograniczenia dla symulacji
dumax=0.09;umax=0.27;
% Macierze wynikowe
y_zad = zeros(1,kk);y_zad(D:kk) = 1;
y=zeros(1,kk);
u=zeros(1,kk);
du = zeros(1,kk);

%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
%%%  Obliczenia
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
% Obliczanie macierzy predykcji
M_P = zeros(N,D-1);
for j=1:(D-1)
    for i=1:N
        M_P(i,j) = skok(i+j) - skok(j);
    end
end

% Wyznaczenie macierzy dynamicznej
M_D = zeros(N, Nu);
for i=1:Nu
    for j=1:N
        if j >= i
            M_D(j+i-1,i) = skok(j);
        else
            M_D(j,i) = 0;
        end
    end
end

% Wyznaczenie macierzy K
K = (M_D'*M_D + lambda*eye(Nu))^-1 * M_D';
K1 = K(1,1:N); ke = sum(K1);
for k=D:kk
    y(k)=b(2)*u(k-3)+b(3)*u(k-4)-a(2)*y(k-1)-a(3)*y(k-2);
    swob = 0;
    for j=1:(D-1)
        ku = K1*M_P(:,j);
        swob = swob + ku*du(k-j);
    end
    du(k) = ke*(y_zad(k) - y(k)) - swob;
    % Ograniczenia
    if(u(k) > umax)
        u(k) = umax;
    end
    if(u(k) < -umax)
        u(k) = -umax;
    end

    if(du(k) > dumax)
        du(k) = dumax;
    end
    if(du(k) < -dumax)
        du(k) = -dumax;
    end

```

```
    u(k) = u(k-1) + du(k);
end
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%
%%%   Drukuje wykres dla wybrancyh wartosci
%%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%% %%%%%

f = figure('visible','off');
t = linspace(1,kk,kk);
hold on
plot(t, y_zad, 'g'); stairs(t, u, 'b'); stairs(t, y, 'r');
grid on
grid minor
legend('y_{zad}(k)', 'u(k)', 'y(k)');
xlabel('k');ylabel('y');
title('DMC dla warto¶ci finalnych');
hold off
print(f, sprintf(strcat('P6_3_DMC_Koncowe_.png')),'-dpng');
```

- Zadanie Dodatkowe

```
% Wybrane wartosci : dulimit = 0.09 , dlimit =
% Model
systems = P1();
sys = systems(:,:,4);
a=sys.Denominator;b=sys.Numerator;T= sys.Ts;
kk=500;
lambda = 2;
D = 50;
Nu = 2;
N = 25;
skok = step(sys,1:T:N+Nu+D);
dumax=0.09;
umax=0.27;
alphaMax = 10;
alphaStart = 1;
for alpha=alphaStart:0.1:alphaMax
    % Wyzerowanie do kolejnych obliczen
    y_zad = zeros(1,kk);
    y_zad(D:kk) = 1;
    y=zeros(1,kk);
    u=zeros(1,kk);
    du = zeros(1,kk);

    % Obliczanie macierzy predykcji
    M_P = zeros(N,D-1);

    for j=1:(D-1)
        for i=1:N
            M_P(i,j) = skok(i+j) - skok(j);
        end
    end

    % Wyznaczenie macierzy dynamicznej
    M_D = zeros(N, Nu);
    for i=1:Nu
        for j=1:N
            if j >= i
                M_D(j+i-1,i) = skok(j);
            else
                M_D(j,i) = 0;
            end
        end
    end



    % Wyznaczenie macierzy K

    K = (M_D'*M_D + lambda*eye(Nu))^-1 * M_D';

    K1 = K(1,1:N);
    ke = sum(K1);

    for k=D:kk
        y(k)=alpha*(b(2)*u(k-3)+b(3)*u(k-4))-a(2)*y(k-1)-a(3)*y(k-2);
        swob = 0;
        for j=1:(D-1)
            ku = K1*M_P(:,j);
            swob = swob + ku*du(k-j);
        end
        du(k) = ke*(y_zad(k) - y(k)) - swob;
```

```
        if(u(k) > umax)
            u(k) = umax;
        end
        if(u(k) < -umax)
            u(k) = -umax;
        end

        if(du(k) > dumax)
            du(k) = dumax;
        end
        if(du(k) < -dumax)
            du(k) = -dumax;
        end

        u(k) = u(k-1) + du(k);
    end

    DMC_Draw(kk, y,y_zad, u,alpha,"Alpha","Dodatkowe");
end
```

- Funkcje pomocnicze

```
function [f] = DMC_Draw(kk, y, y_zad,u,value,valueDescrpitor,dir)

f = figure('visible','off');
t = linspace(1,kk,kk);
hold on
plot(t, y_zad, 'g'); stairs(t, u, 'b'); stairs(t, y, 'r');
grid on
grid minor
legend('y_{zad}(k)', 'u(k)', 'y(k)');
xlabel('k');ylabel('y');
title(sprintf(strcat('DMC dla ' ,' ' , valueDescrpitor , ' = ' ,
    num2str(value))) );
hold off
fileName = strcat('Models',dir,'_' ,valueDescrpitor, '/P4_DMC_' ,
    valueDescrpitor, '_', num2str(value),".png");
fileName = strrep(fileName,".","_");
fileName = sprintf(strcat(fileName));
print(f,fileName,'-dpng');
```

```
function[y,y_zad,u,Jy,Ju] = DMCnoLimit(sys,N,Nu,D,lambda,kk)
% Model
a=sys.Denominator;b=sys.Numerator;T= sys.Ts;
skok = step(sys,1:T:N+Nu+D);


% Wyzerowanie do kolejnych obliczen
y_zad = zeros(1,kk);
y_zad(D:kk) = 1;
y=zeros(1,kk);
u=zeros(1,kk);
du = zeros(1,kk);

% Obliczanie macierzy predykcji
M_P = zeros(N,D-1);

for j=1:(D-1)
    for i=1:N
        M_P(i,j) = skok(i+j) - skok(j);
    end
end

% Wyznaczenie macierzy dynamicznej
M_D = zeros(N, Nu);
for i=1:Nu
    for j=1:N
        if j >= i
            M_D(j+i-1,i) = skok(j);
        else
            M_D(j,i) = 0;
        end
    end
end



% Wyznaczenie macierzy K

K = (M_D'*M_D + lambda*eye(Nu))^-1 * M_D';

K1 = K(1,1:N);
```

```
ke = sum(K1);

for k=D:kk
    y(k)=b(2)*u(k-3)+b(3)*u(k-4)-a(2)*y(k-1)-a(3)*y(k-2);
    swob = 0;
    for j=1:(D-1)
        ku = K1*M_P(:,j);
        swob = swob + ku*du(k-j);
    end
    du(k) = ke*(y_zad(k) - y(k)) - swob;
    u(k) = u(k-1) + du(k);
end
[Jy,Ju] = getJ(y,y_zad,u,kk);
```

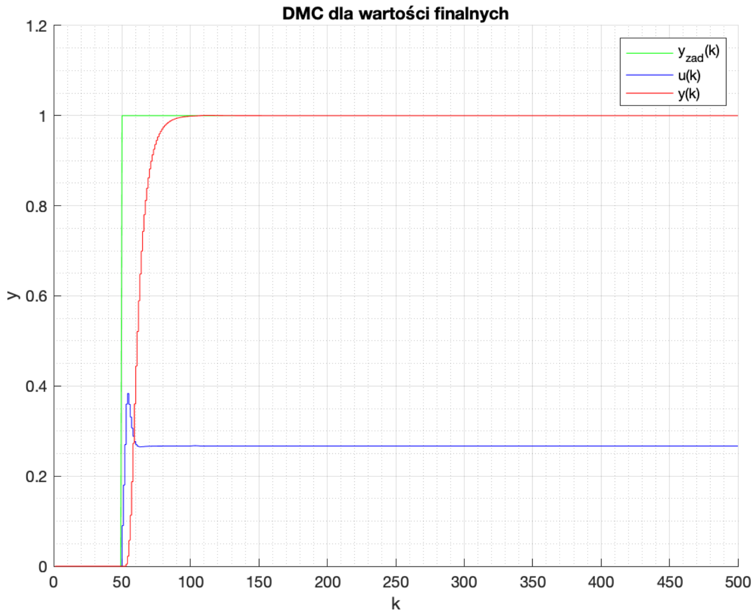
```
function [f] = DrawJ(J,value,whichJ)

f = figure('visible','off');
hold on
plot(J(:,2),J(:,1), 'g');
grid on
grid minor
legend(whichJ);
ylabel(whichJ);xlabel(value);
title(whichJ);
hold off
print(f, ['ModelsP4_J/',whichJ ,value,'.png'],'-dpng');
```

```
function [u,y] = getDataFromFile(fileName)
A = importdata(fileName);
u = A(:,1);
y = A(:,2);
```

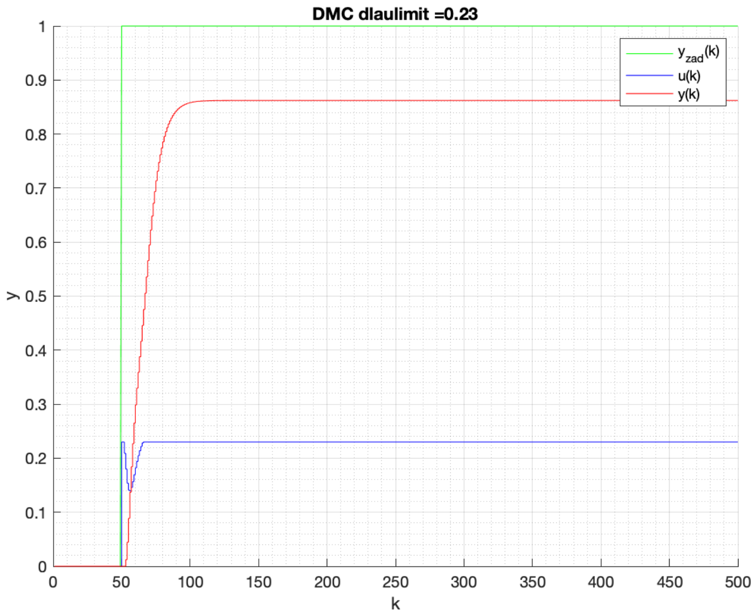
```
function[Jy,Ju]  = getJ(y,yzad,u,kk)
Jy = 0;
Ju = 0;
for i=1 : kk
    Jy = Jy +(y(kk)-yzad(kk))^2;
end
for i=2 : kk
    Ju = Ju +(u(kk)-u(kk-1))^2;
end
```

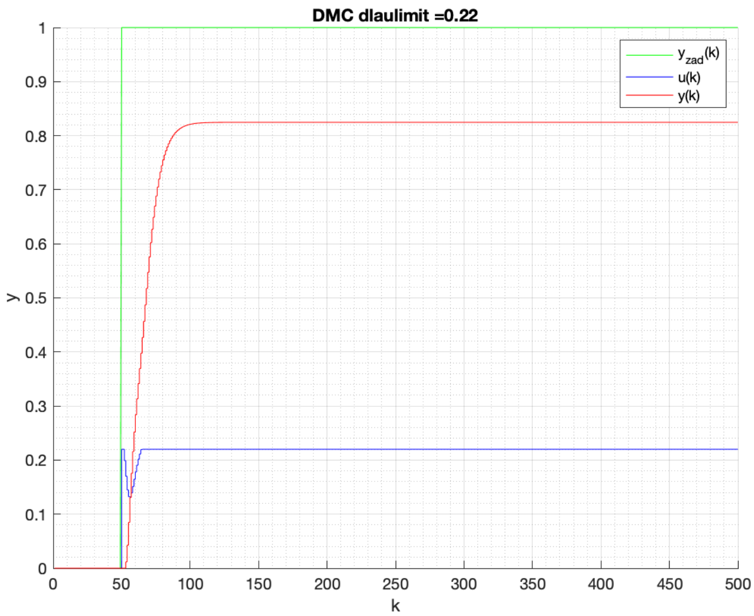
```
function [E] = getSquareError(y1,y2)
E = 0;
for i = 1:size(y1)
    E=+ (y1(i) - y2(i))^2;
end
```

```
function [l] = hlprTFtoLatex(tf,precision)
[num,den] = tfdata(tf);
den= cell2mat(den);
den = den(2:3);
syms('z');
digits(precision);
t_sym = poly2sym(vpa(cell2mat(num)),z)/poly2sym(vpa(den),z);
l=latex(t_sym);
```

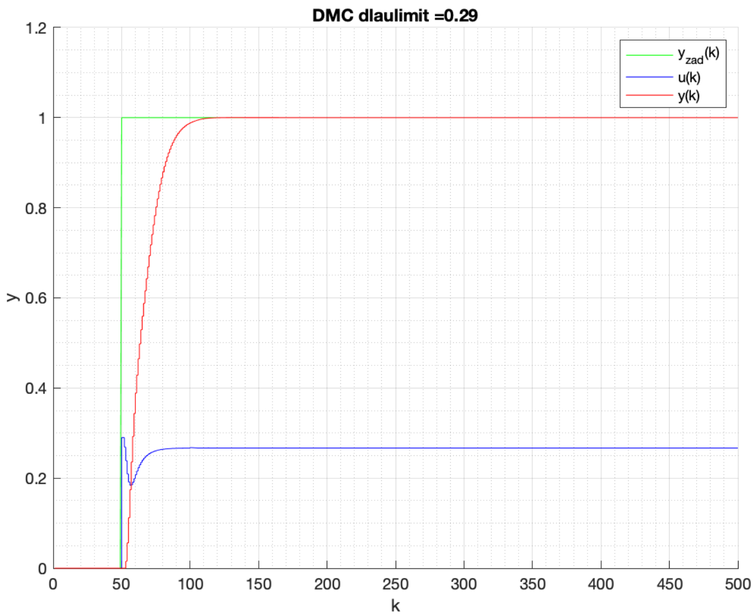

DMC dla wartości finalnych
$y_{zad}(k)$
u(k)
y(k)
y
k

2. Wykresy

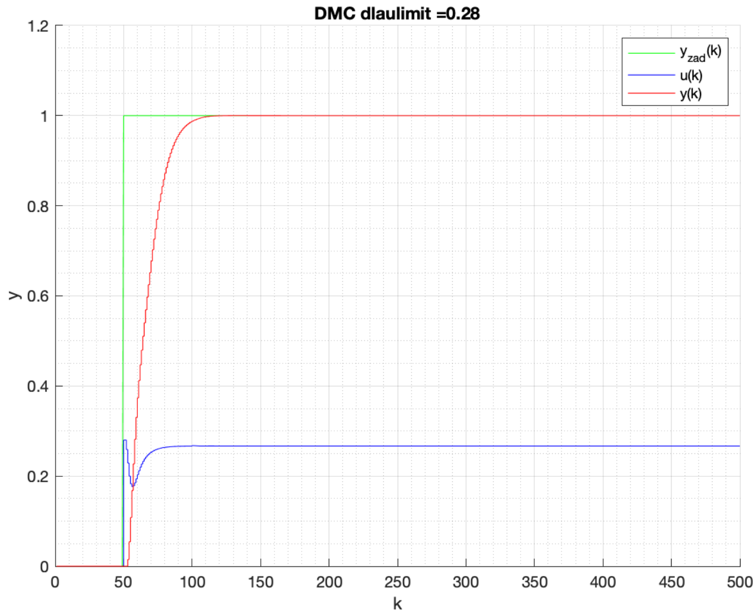

DMC dlaulimit =0.23
$y_{zad}(k)$
u(k)
y(k)
y
k

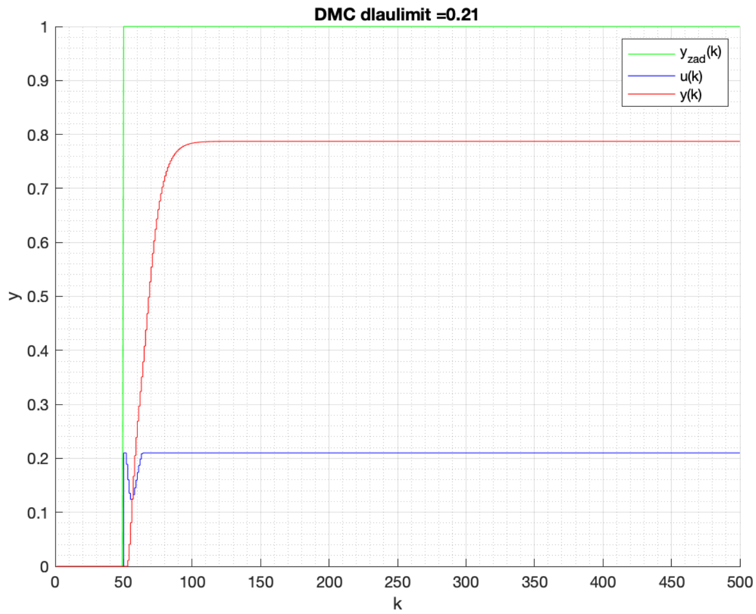


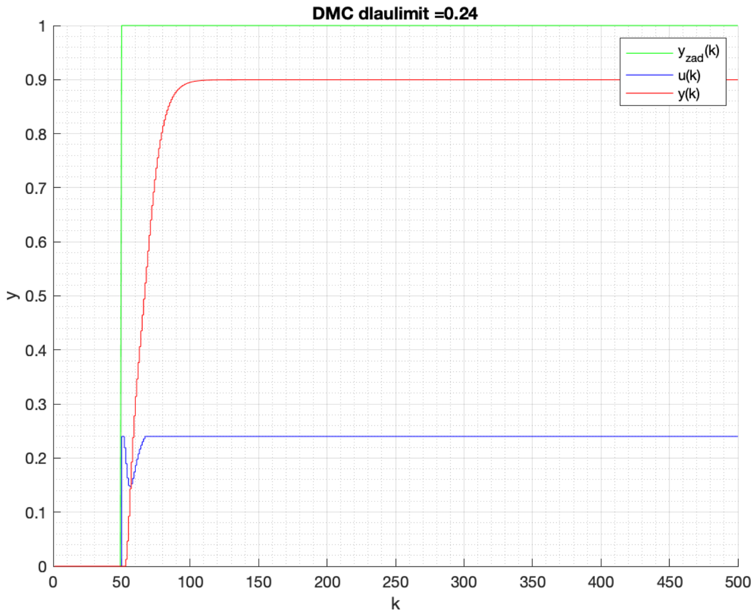
DMC dlaulimit =0.22
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
50
100
150
200
250
300
350
400
450
500

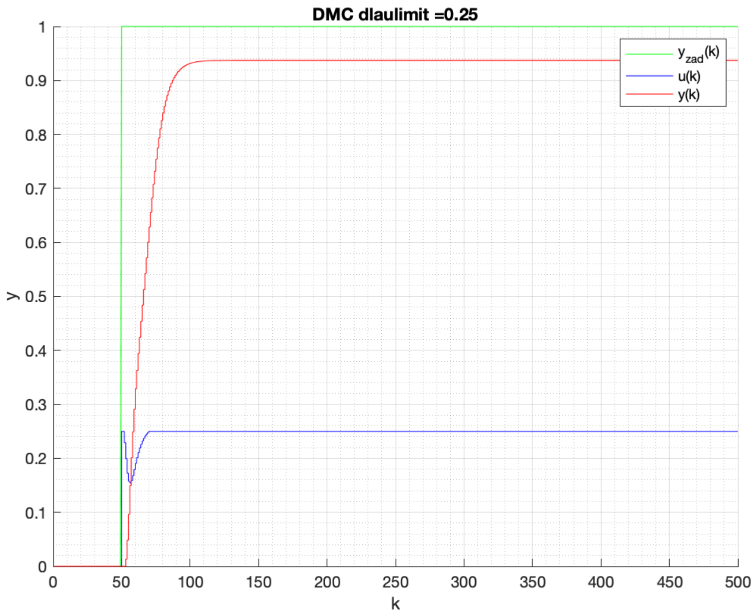


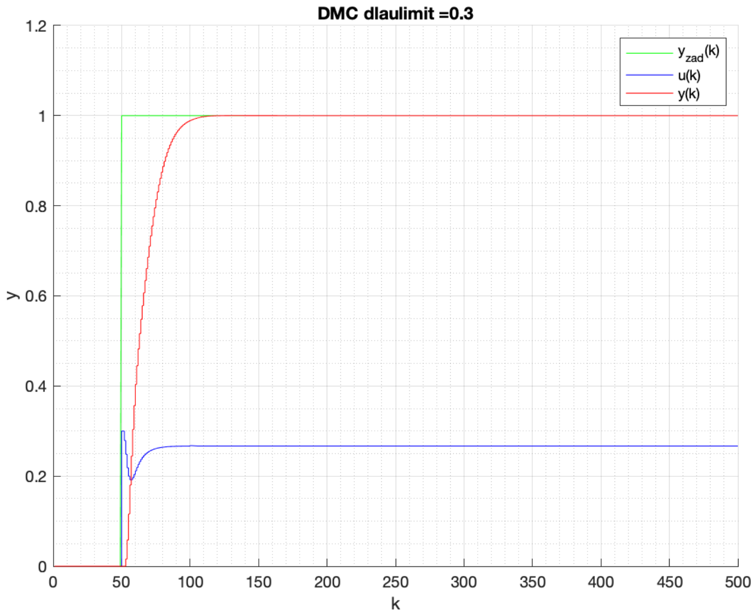
DMC dlaulimit =0.29
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
50
100
150
200
250
300
350
400
450
500

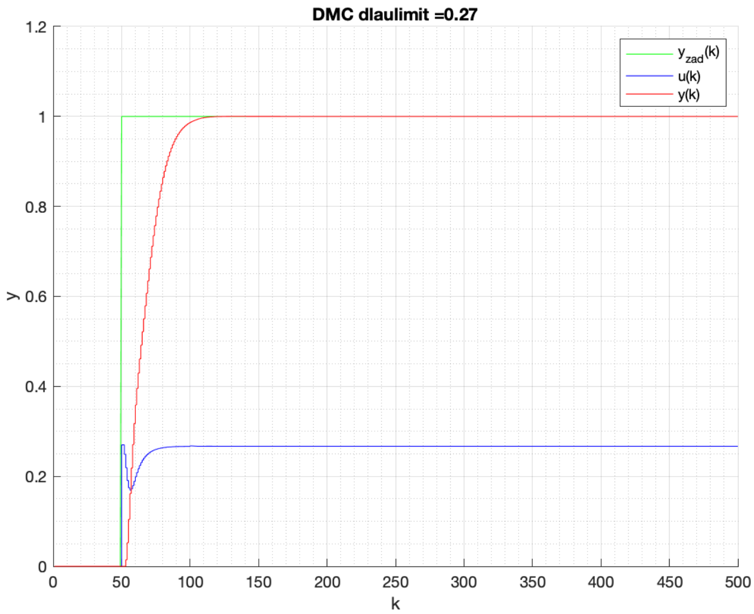

DMC dlaulimit =0.28
y
k
$y_{zad}(k)$
u(k)
y(k)

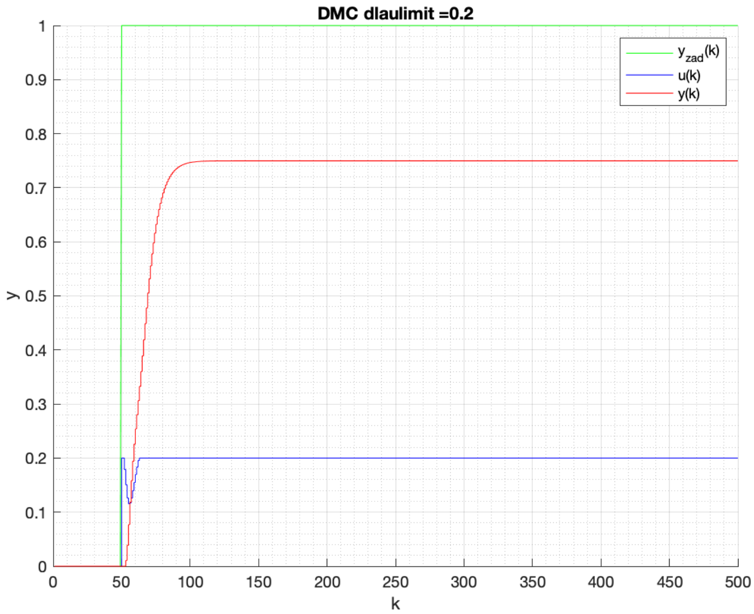

DMC dlaulimit =0.21
y
k
$y_{zad}(k)$
u(k)
y(k)

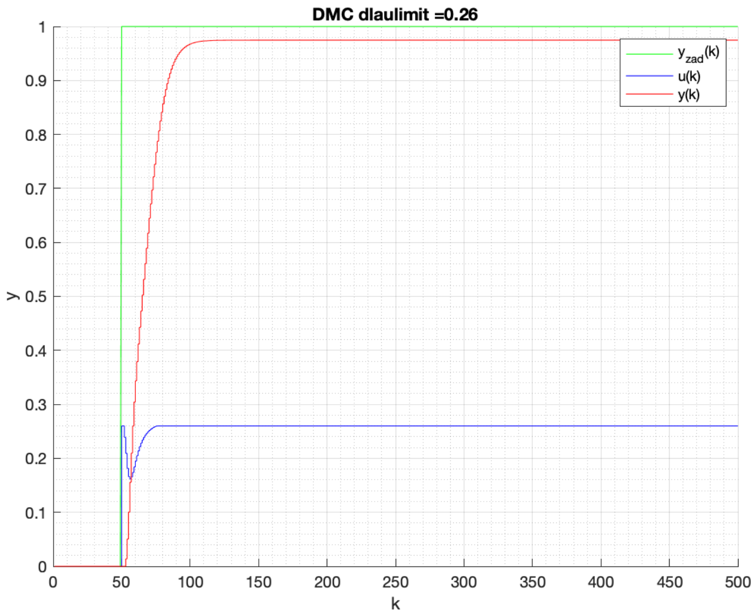

DMC dlaulimit =0.24
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

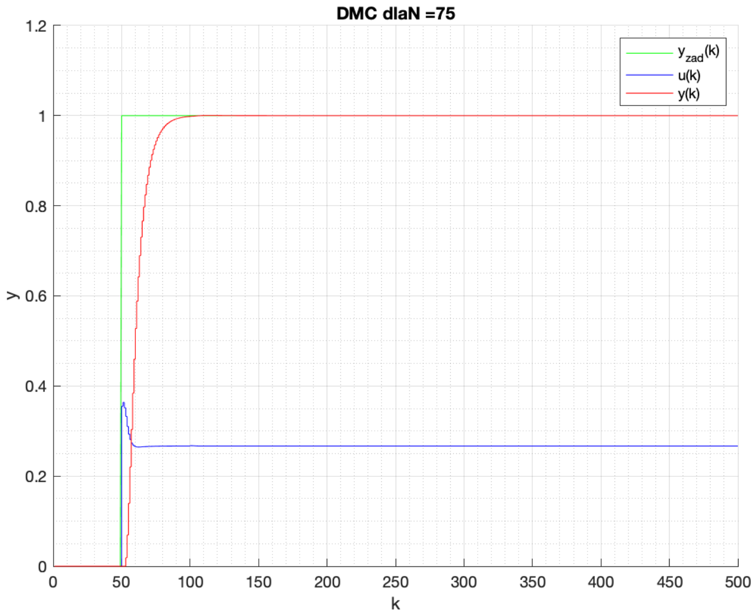

DMC dlaulimit =0.25
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

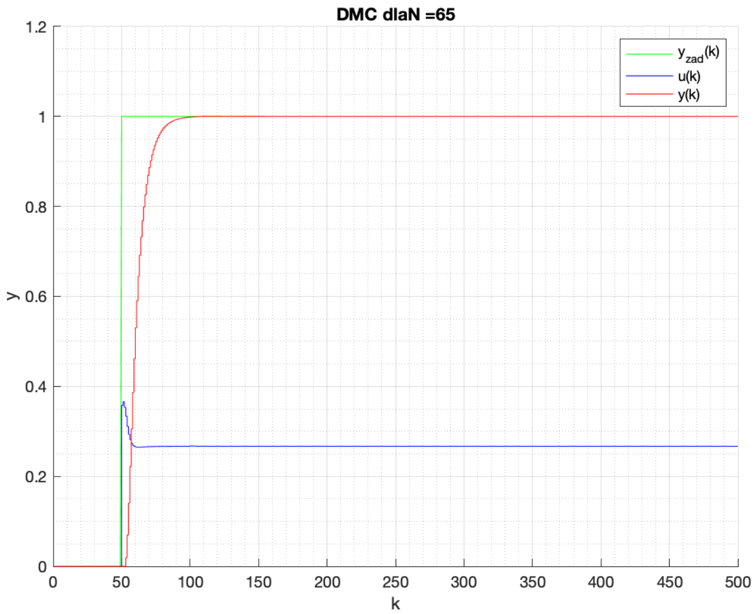

DMC dlaulimit =0.3
y
k
y_zad(k)
u(k)
y(k)

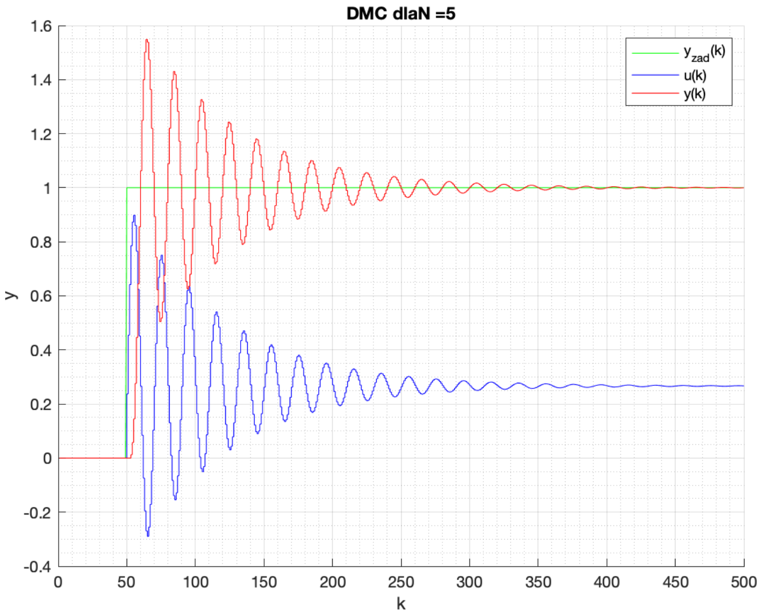

DMC dlaulimit =0.27
y
k
y_zad(k)
u(k)
y(k)

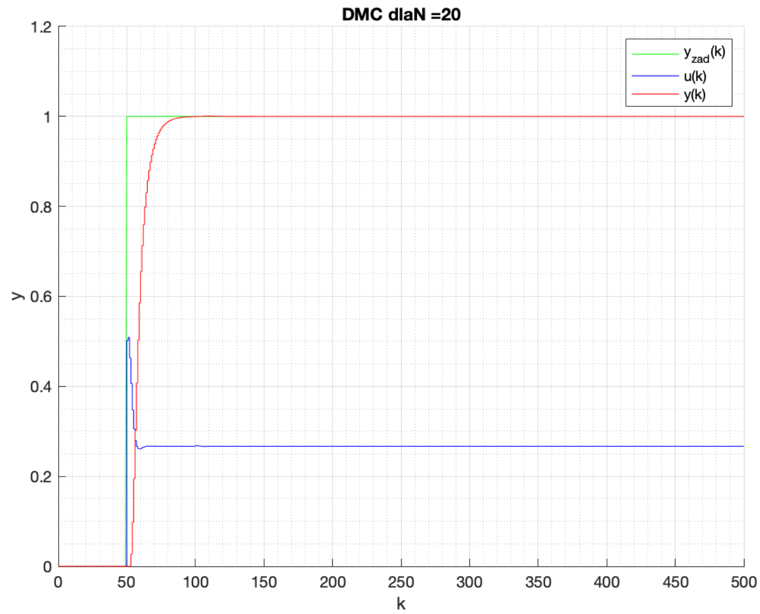

DMC dlaulimit =0.2
y
k
yzad(k)
u(k)
y(k)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
50
100
150
200
250
300
350
400
450
500

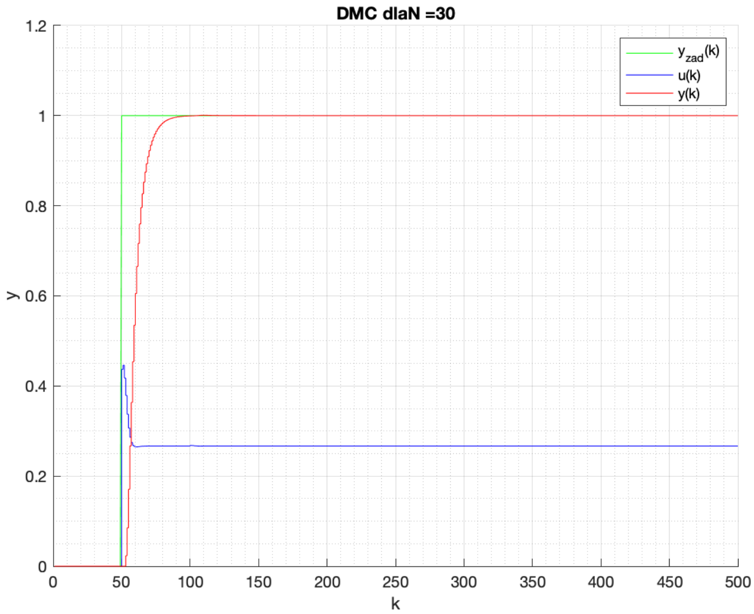

DMC dlaulimit =0.26
y
k
yzad(k)
u(k)
y(k)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
50
100
150
200
250
300
350
400
450
500

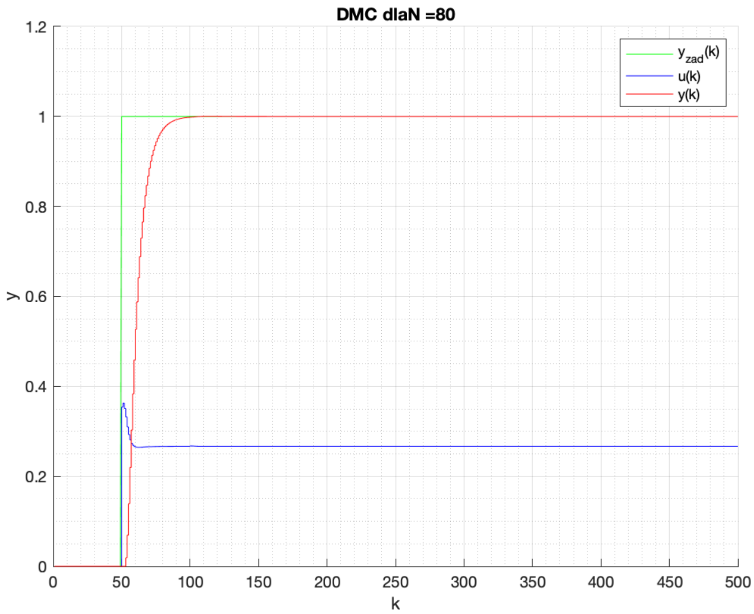

DMC dlaN =75
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

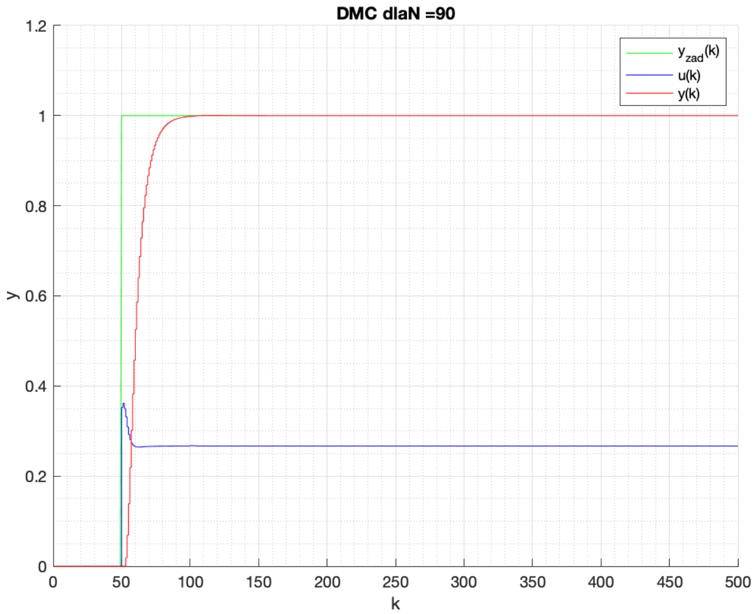

DMC dlaN =65
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500


DMC dlaN =5
$y_{zad}(k)$
u(k)
y(k)
y
k
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0
50
100
150
200
250
300
350
400
450
500

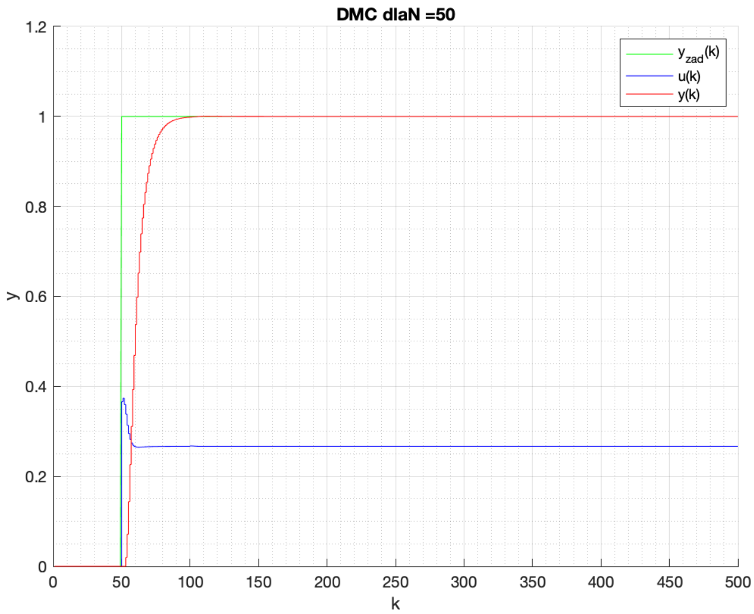

DMC dlaN =20
$y_{zad}(k)$
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500


DMC dlaN =30
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

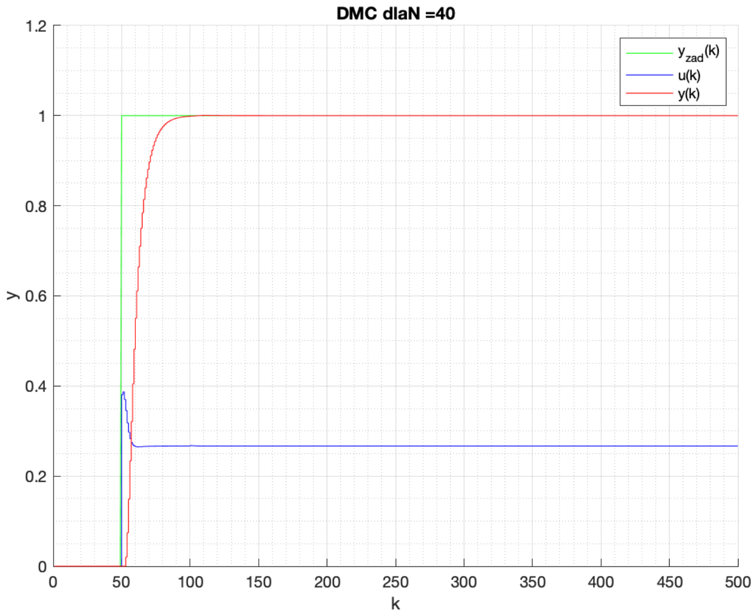

DMC dlaN =80
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500



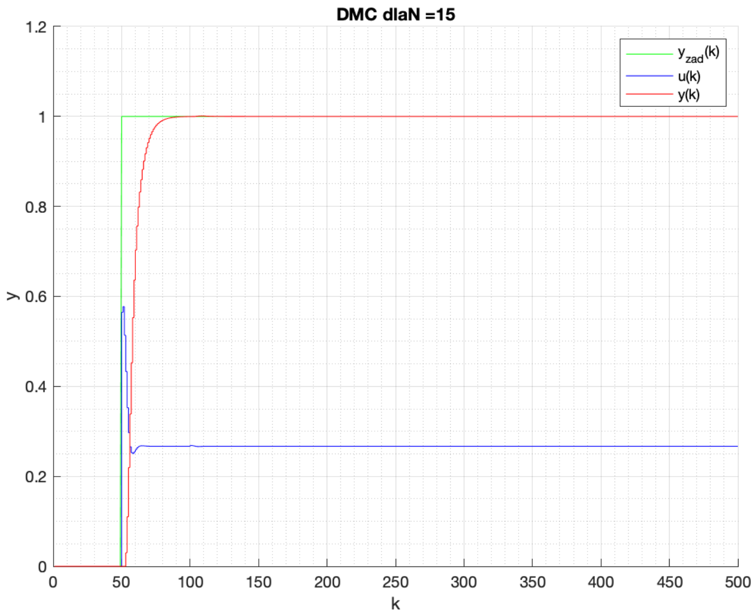
DMC dlaN =90
$y_{zad}(k)$
u(k)
y(k)
y
k



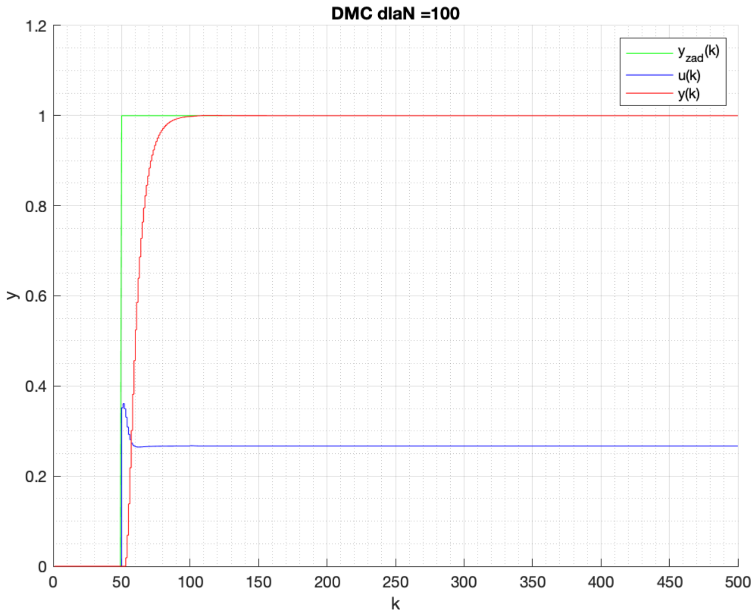
DMC dlaN =50
$y_{zad}(k)$
u(k)
y(k)
y
k

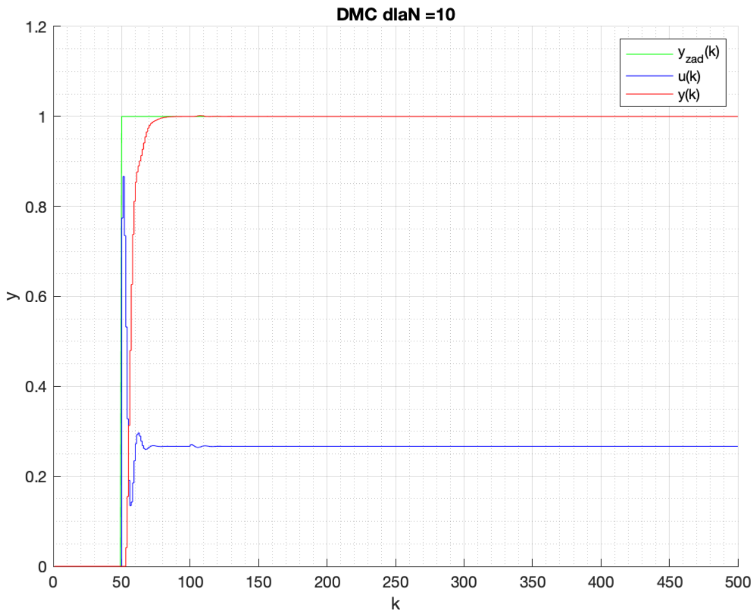


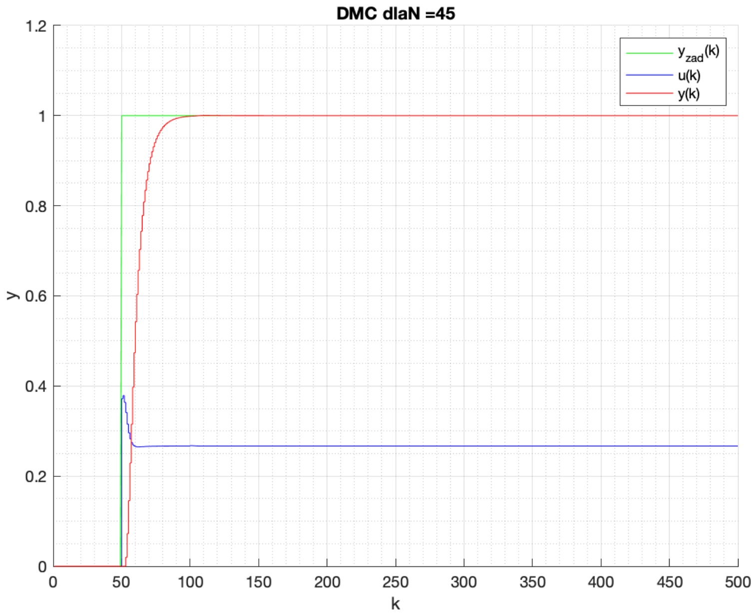
DMC dlaN =40
$y_{zad}(k)$
u(k)
y(k)
y
k

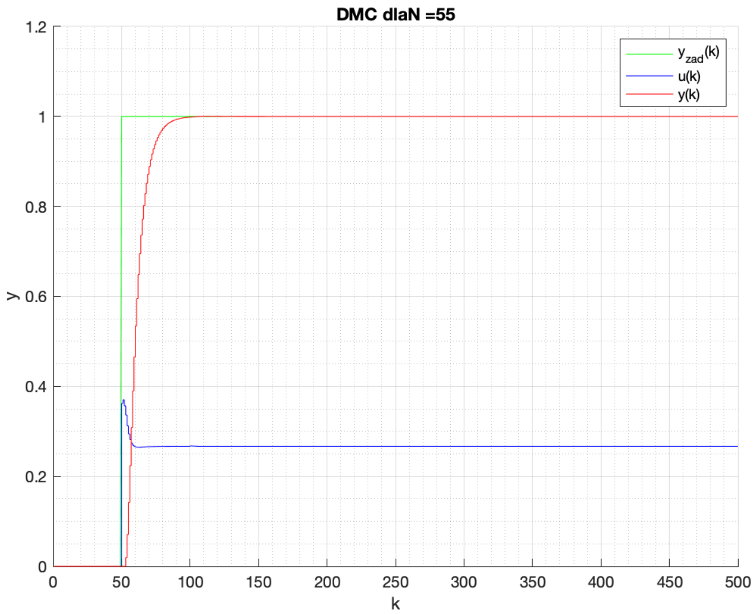


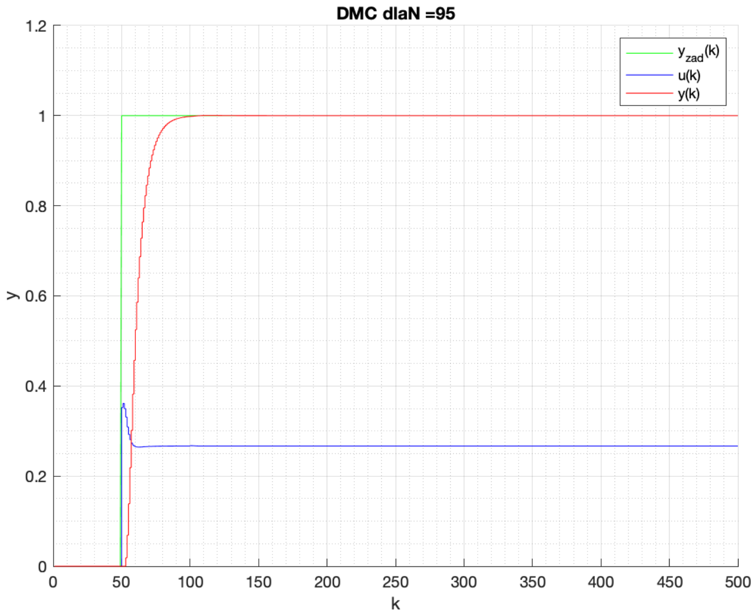
DMC dlaN =15
$y_{zad}(k)$
u(k)
y(k)
y
k

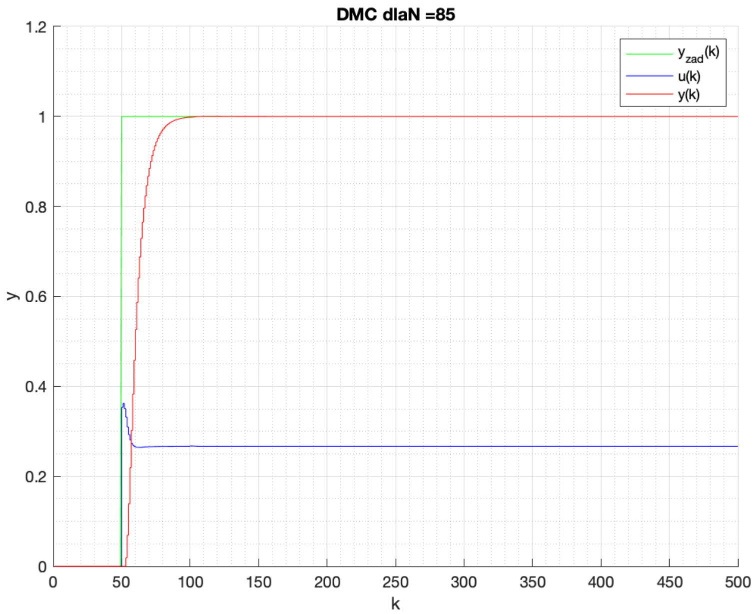

DMC dlaN =100
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

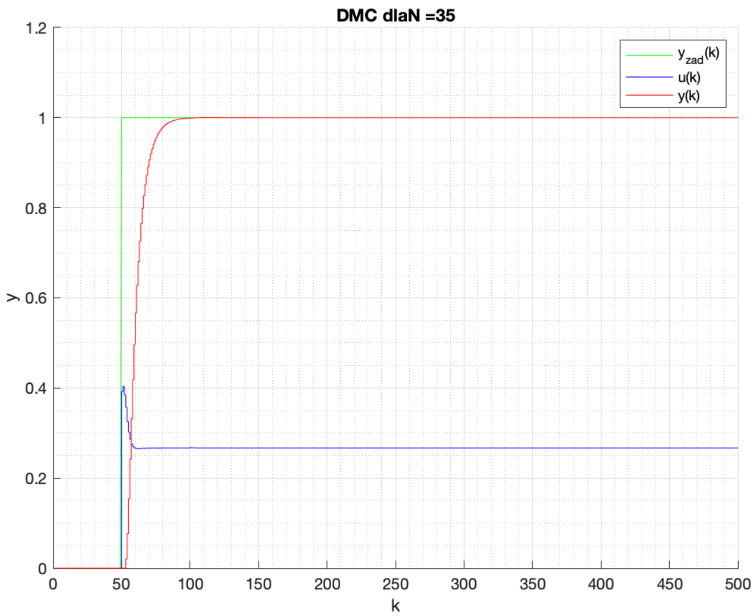

DMC dlaN =10
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

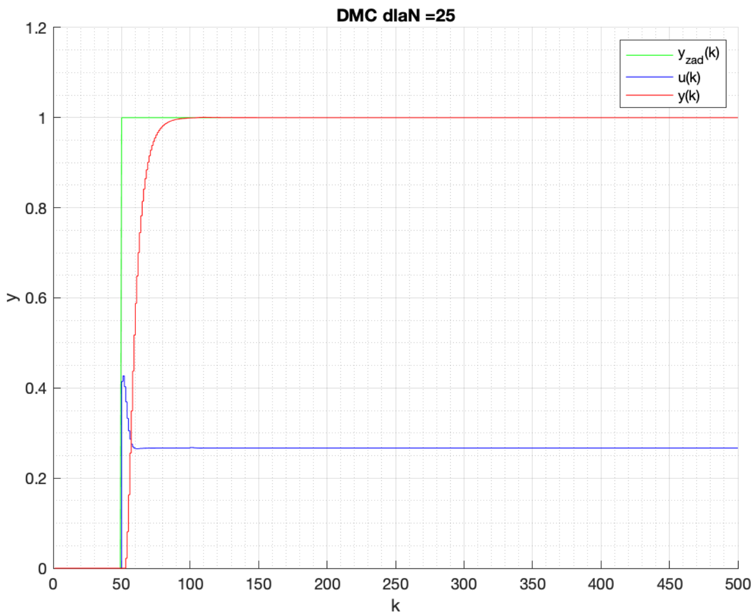

DMC dlaN =45
y
k
$y_{zad}(k)$
u(k)
y(k)

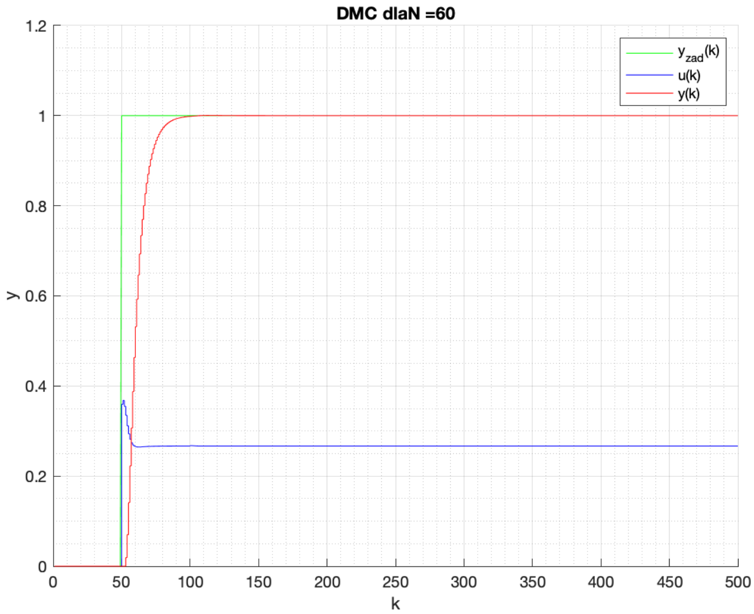

DMC dlaN =55
y
k
$y_{zad}(k)$
u(k)
y(k)

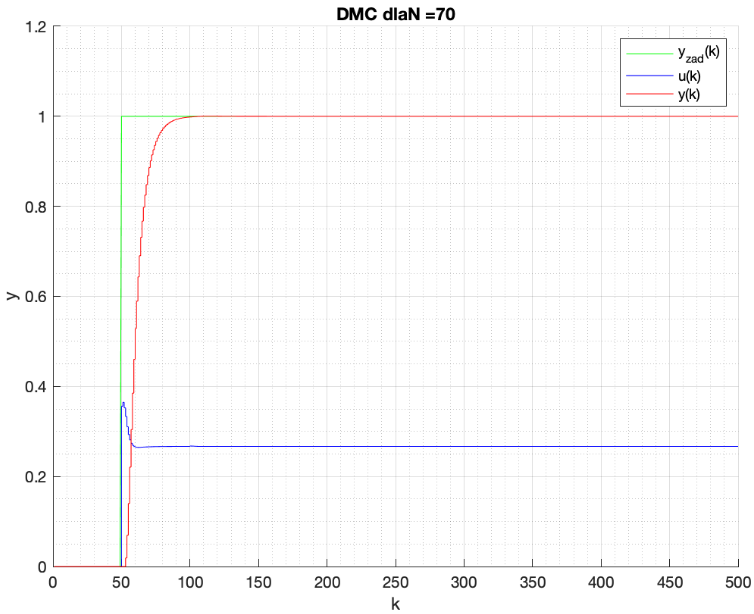

DMC dlaN =95
$y_{zad}(k)$
u(k)
y(k)
y
k

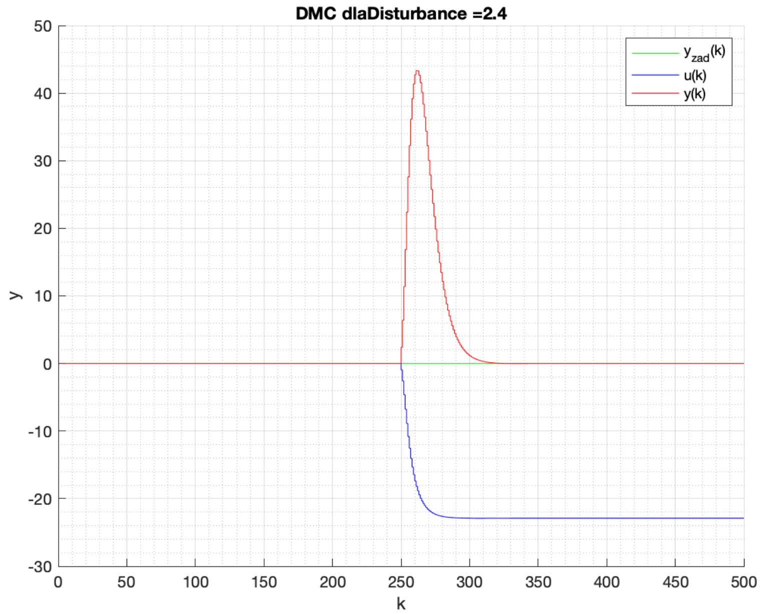

DMC dlaN =85
$y_{zad}(k)$
u(k)
y(k)
y
k

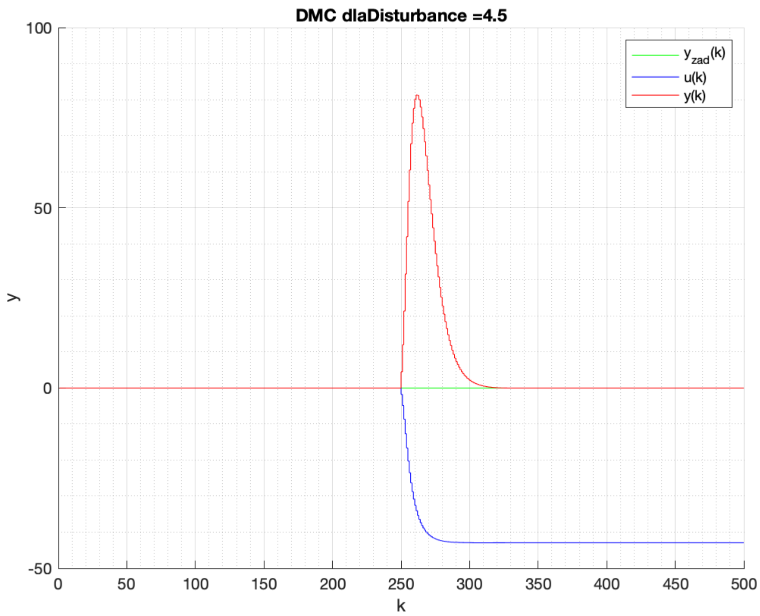

DMC dlaN =35
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

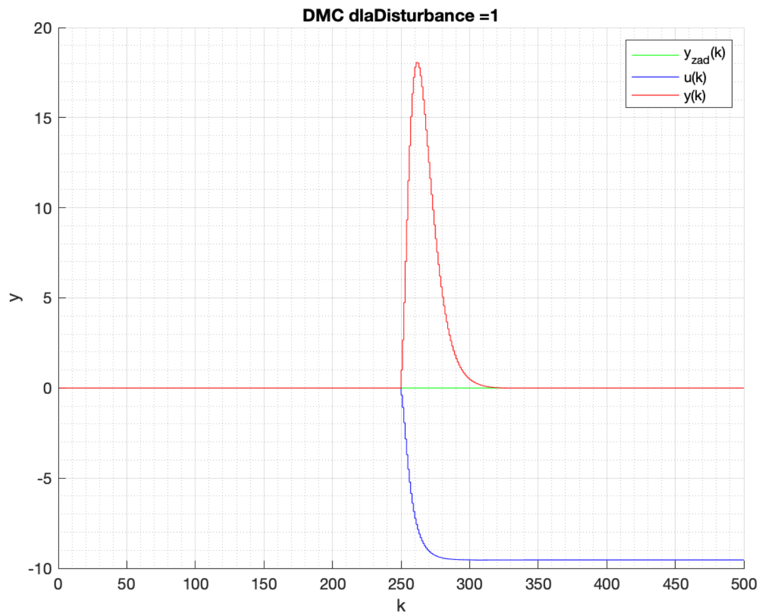

DMC dlaN =25
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

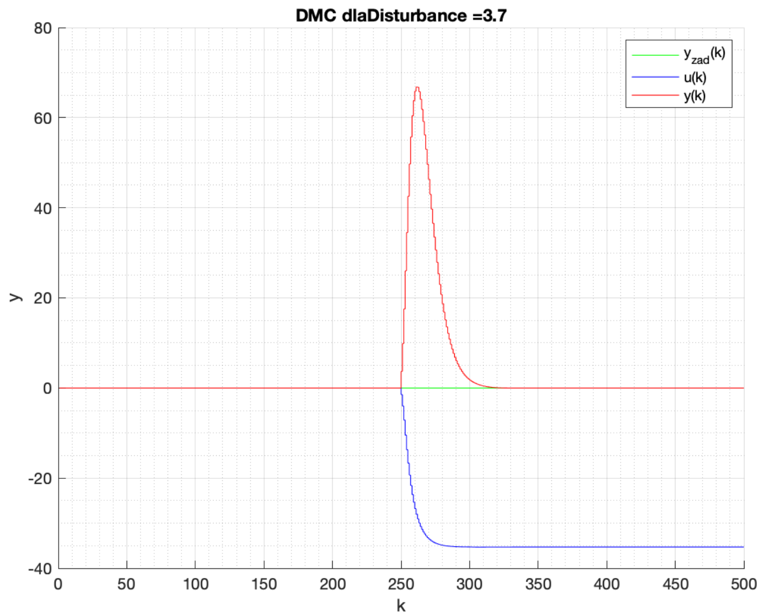

DMC dlaN =60
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

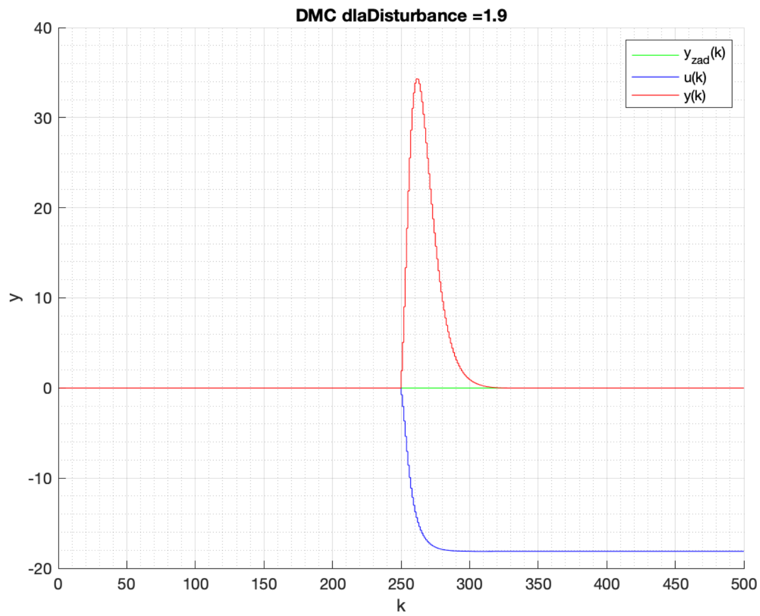

DMC dlaN =70
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

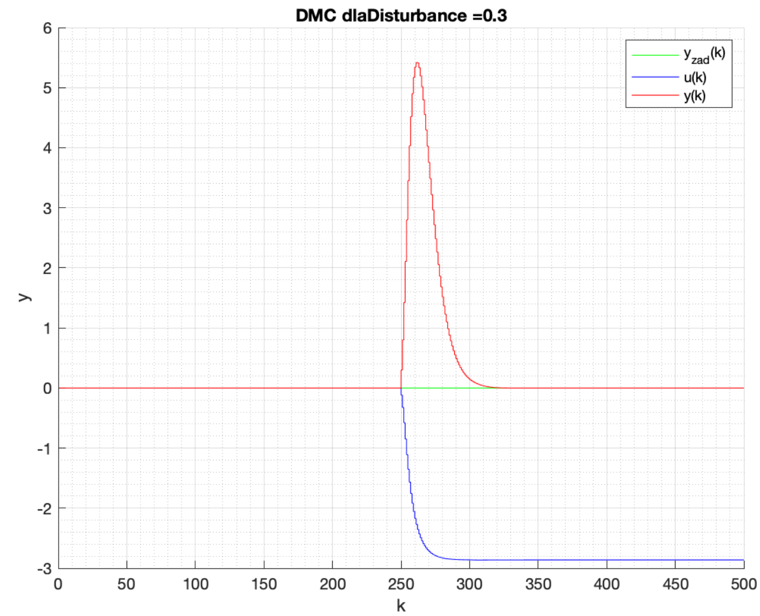

DMC dlaDisturbance =2.4
$y_{zad}(k)$
u(k)
y(k)
y
k
50
40
30
20
10
0
-10
-20
-30
0
50
100
150
200
250
300
350
400
450
500

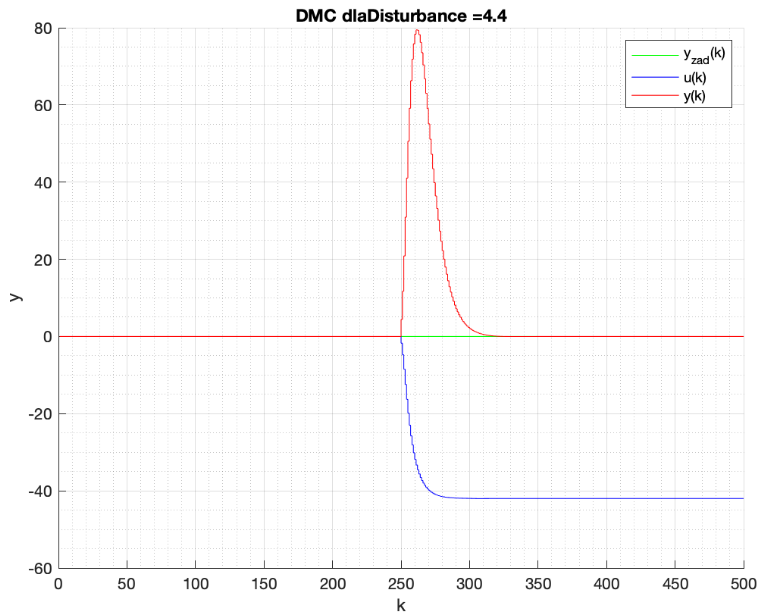

DMC dlaDisturbance =4.5
$y_{zad}(k)$
u(k)
y(k)
y
k
100
50
0
-50
0
50
100
150
200
250
300
350
400
450
500

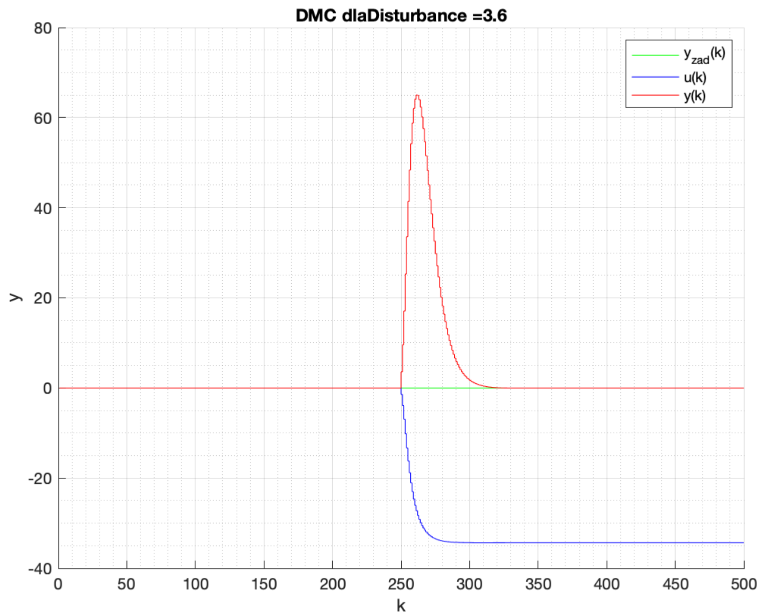

DMC dlaDisturbance =1
y_zad(k)
u(k)
y(k)
y
k
20
15
10
5
0
-5
-10
0
50
100
150
200
250
300
350
400
450
500

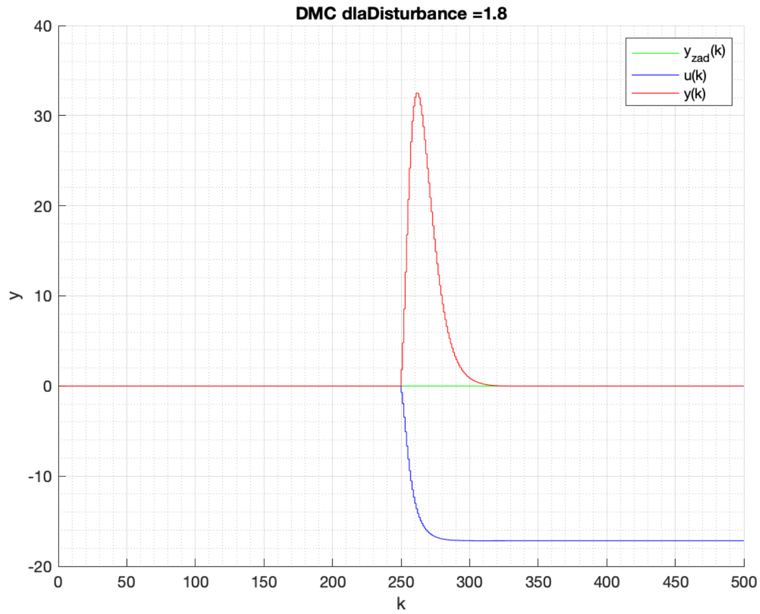

DMC dlaDisturbance =3.7
y_zad(k)
u(k)
y(k)
y
k
80
60
40
20
0
-20
-40
0
50
100
150
200
250
300
350
400
450
500


DMC dlaDisturbance =1.9
y
k
$y_{zad}(k)$
u(k)
y(k)
40
30
20
10
0
-10
-20
0
50
100
150
200
250
300
350
400
450
500

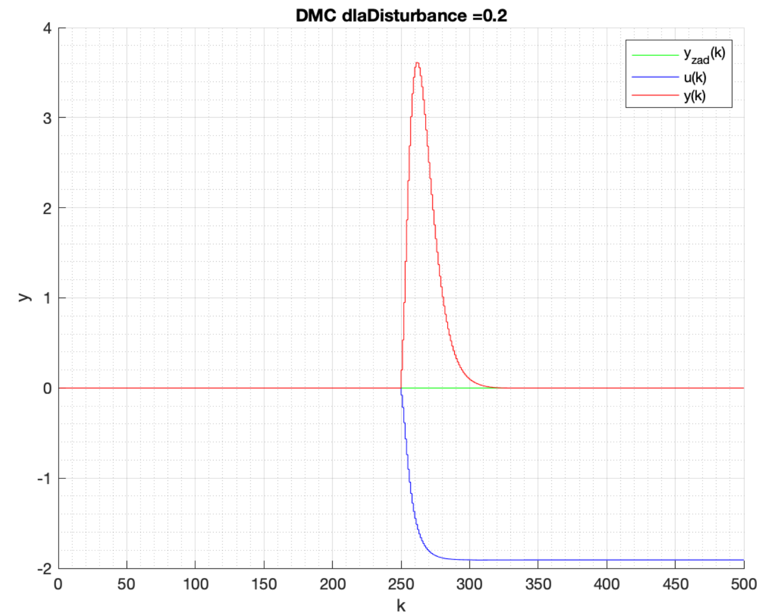

DMC dlaDisturbance =0.3
y
k
$y_{zad}(k)$
u(k)
y(k)
6
5
4
3
2
1
0
-1
-2
-3
0
50
100
150
200
250
300
350
400
450
500


DMC dlaDisturbance =4.4
$y_{zad}(k)$
u(k)
y(k)
y
k
80
60
40
20
0
-20
-40
-60
0
50
100
150
200
250
300
350
400
450
500

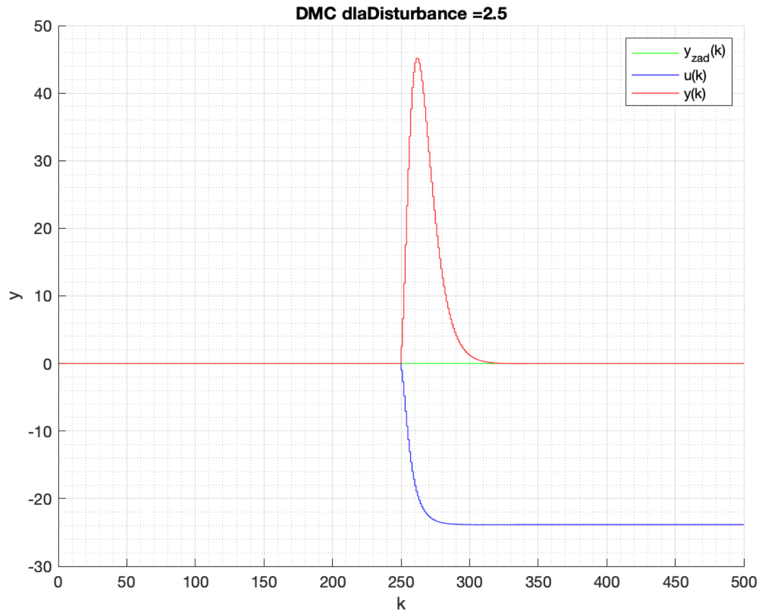

DMC dlaDisturbance =3.6
$y_{zad}(k)$
u(k)
y(k)
y
k
80
60
40
20
0
-20
-40
0
50
100
150
200
250
300
350
400
450
500

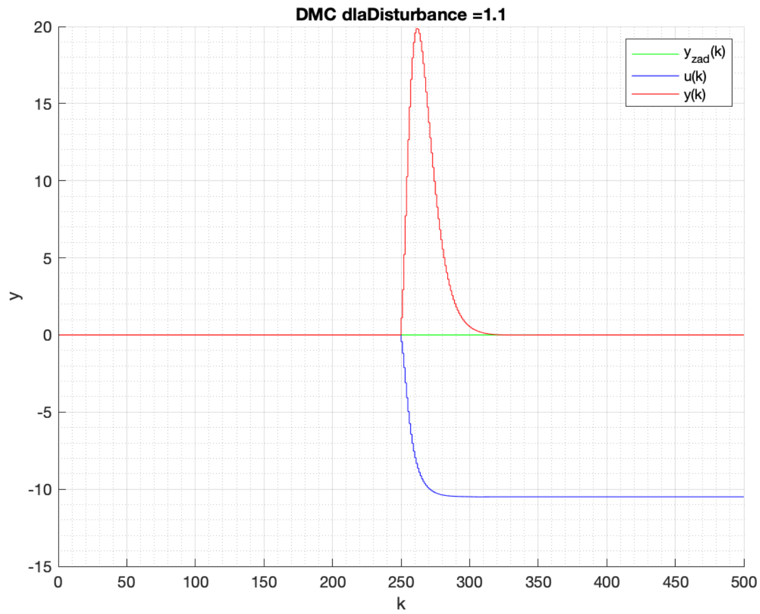


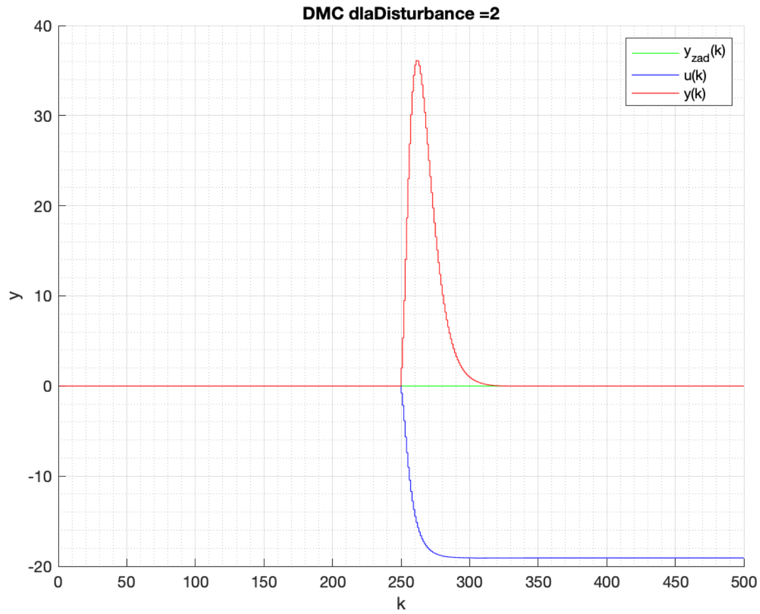
DMC dlaDisturbance =1.8
y
k
y_zad(k)
u(k)
y(k)



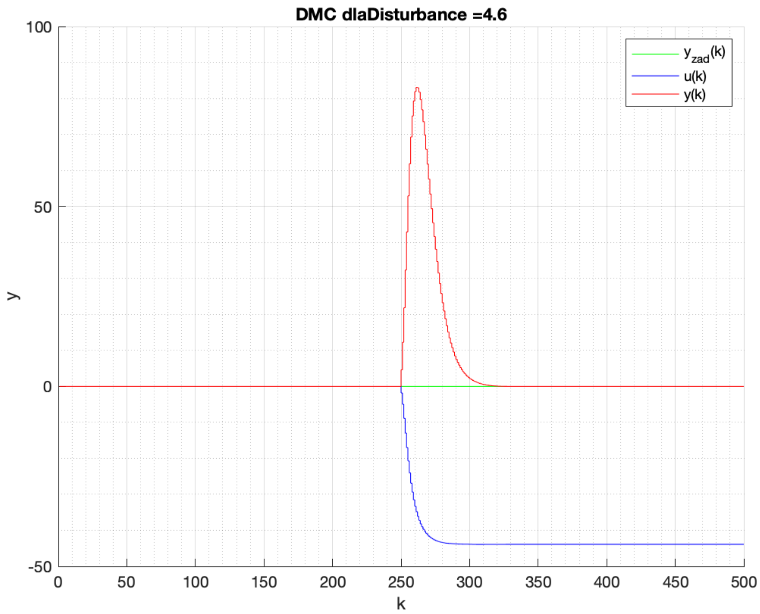
DMC dlaDisturbance =0.2
y
k
y_zad(k)
u(k)
y(k)


DMC dlaDisturbance =2.5
$y_{zad}(k)$
u(k)
y(k)
y
k
50
40
30
20
10
0
-10
-20
-30
0
50
100
150
200
250
300
350
400
450
500

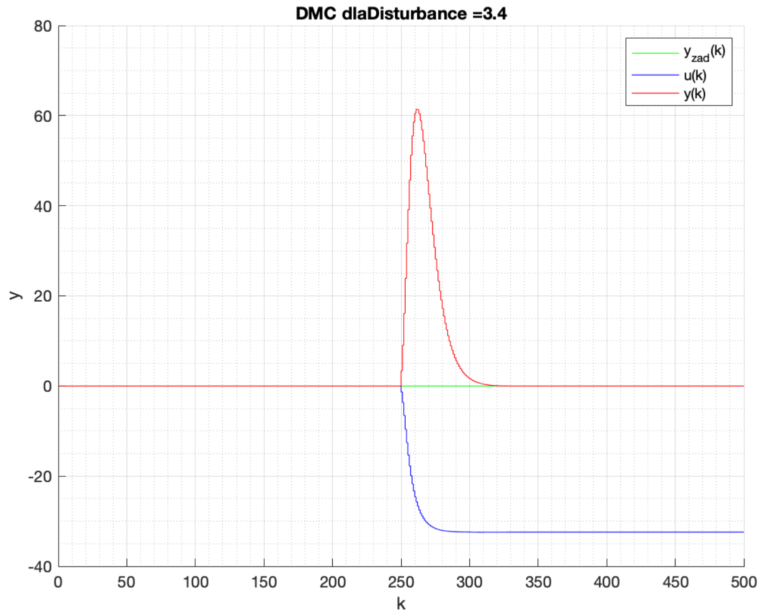

DMC dlaDisturbance =1.1
$y_{zad}(k)$
u(k)
y(k)
y
k
20
15
10
5
0
-5
-10
-15
0
50
100
150
200
250
300
350
400
450
500

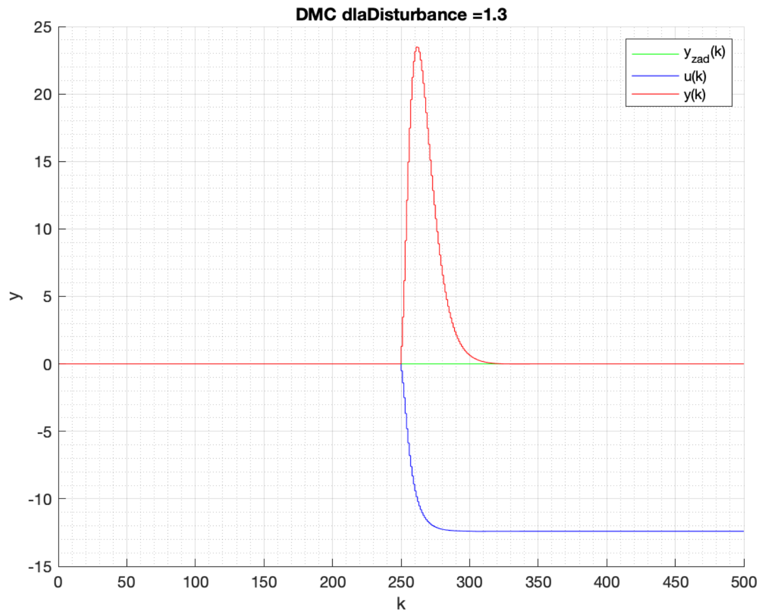


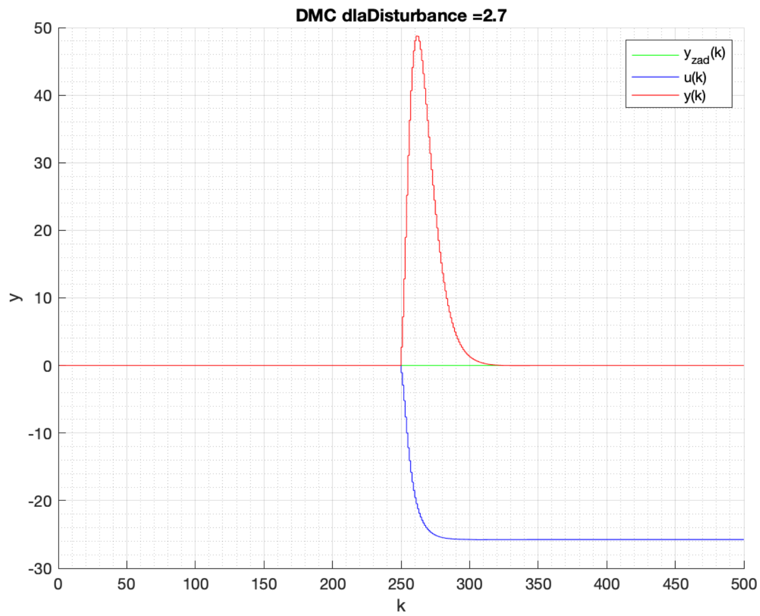
DMC dlaDisturbance =2
y
k
y_zad(k)
u(k)
y(k)
40
30
20
10
0
-10
-20
0
50
100
150
200
250
300
350
400
450
500

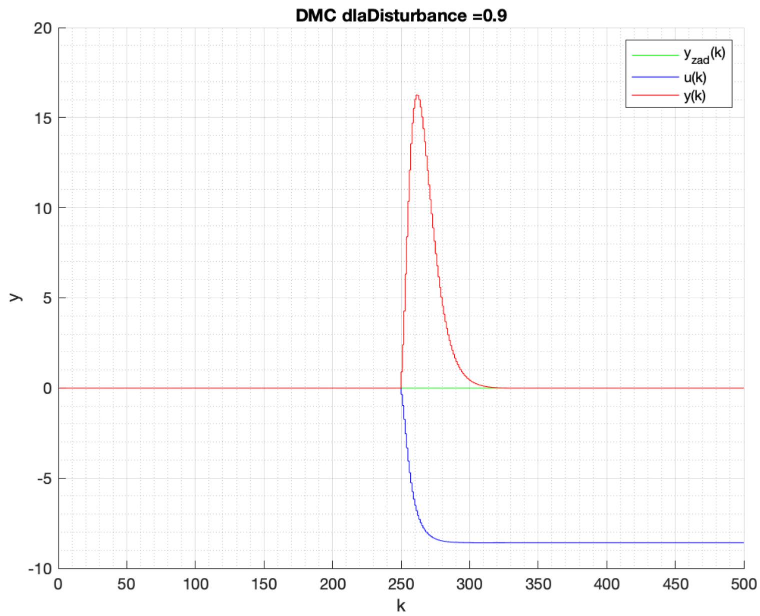


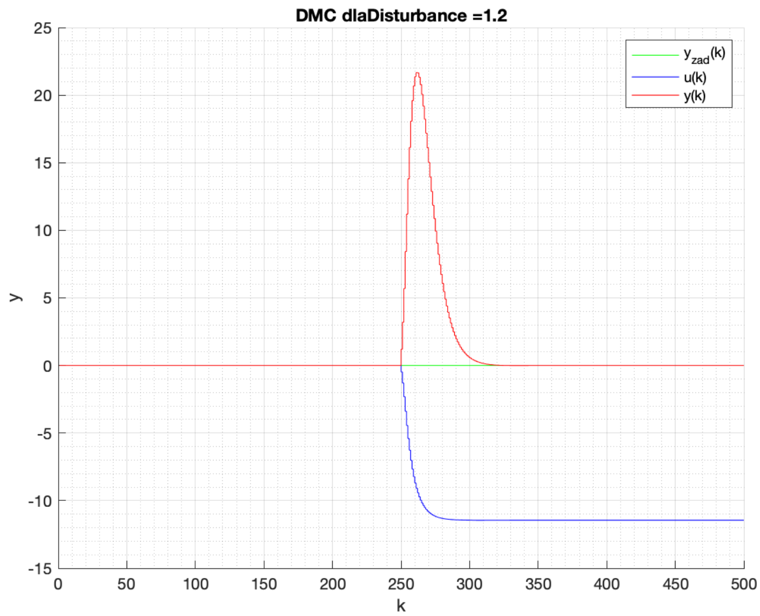
DMC dlaDisturbance =4.6
y
k
y_zad(k)
u(k)
y(k)
100
50
0
-50
0
50
100
150
200
250
300
350
400
450
500

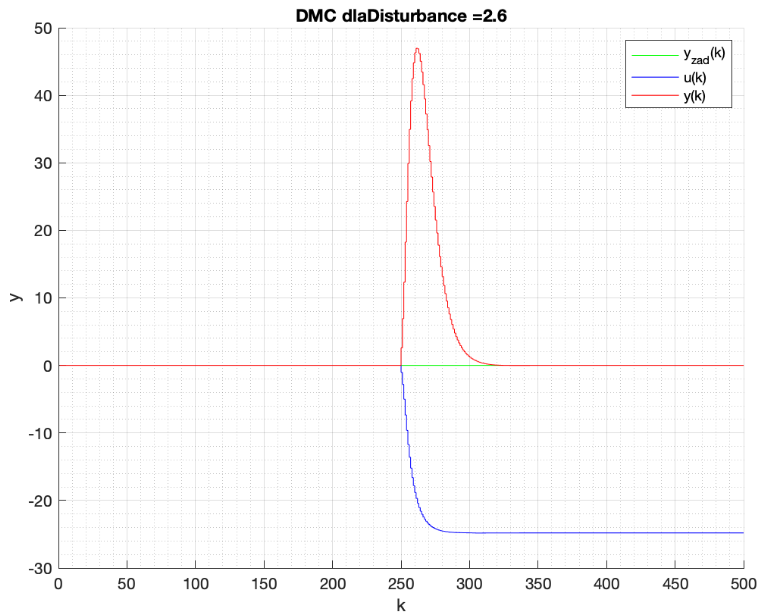

DMC dlaDisturbance =3.4
$y_{zad}(k)$
u(k)
y(k)
y
k
80
60
40
20
0
-20
-40
0
50
100
150
200
250
300
350
400
450
500

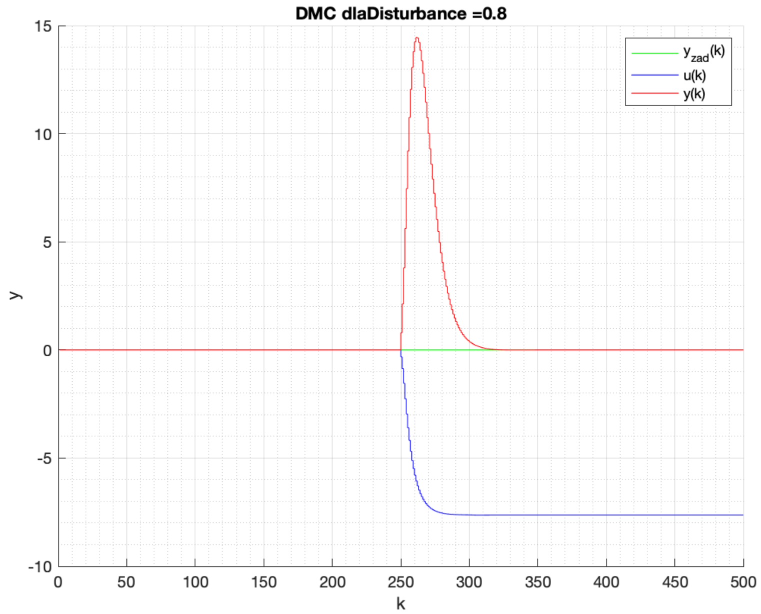

DMC dlaDisturbance =1.3
$y_{zad}(k)$
u(k)
y(k)
y
k
25
20
15
10
5
0
-5
-10
-15
0
50
100
150
200
250
300
350
400
450
500

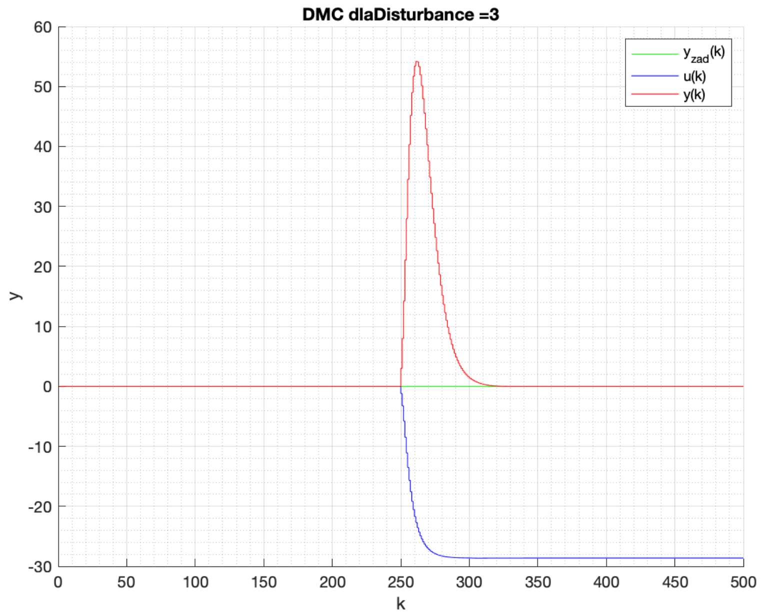

DMC dlaDisturbance =2.7
$y_{zad}(k)$
u(k)
y(k)
y
k

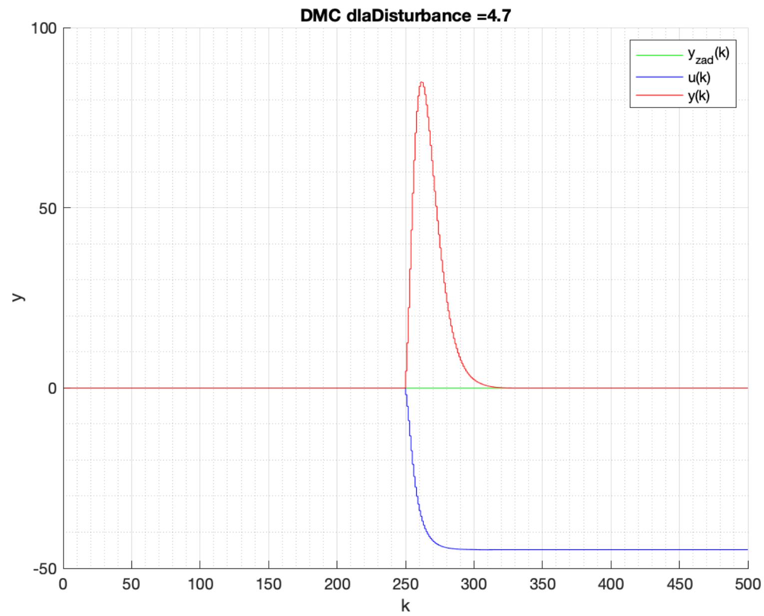

DMC dlaDisturbance =0.9
$y_{zad}(k)$
u(k)
y(k)
y
k

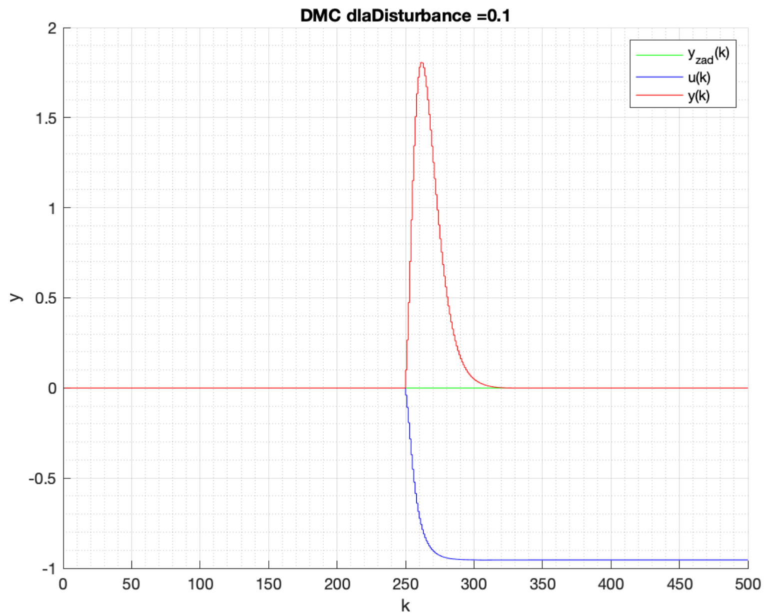

DMC dlaDisturbance =1.2
y
k
$y_{zad}(k)$
u(k)
y(k)
25
20
15
10
5
0
-5
-10
-15
0
50
100
150
200
250
300
350
400
450
500

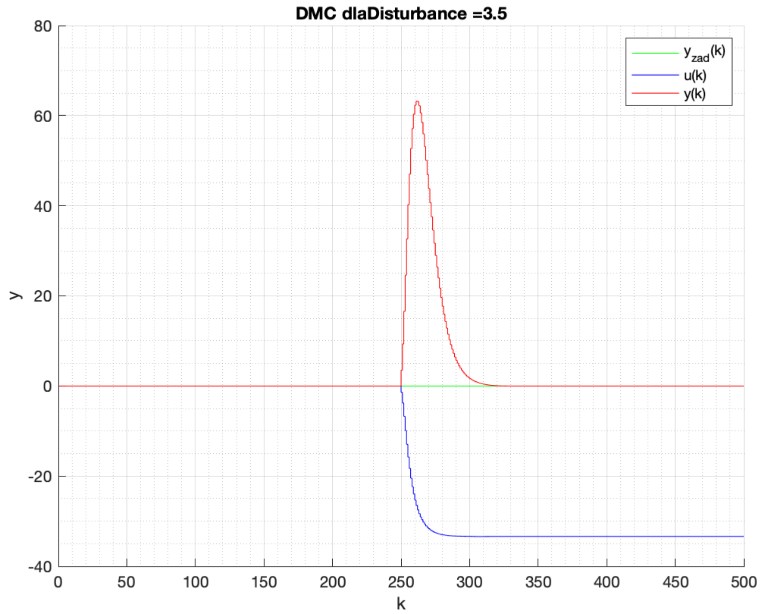

DMC dlaDisturbance =2.6
y
k
$y_{zad}(k)$
u(k)
y(k)
50
40
30
20
10
0
-10
-20
-30
0
50
100
150
200
250
300
350
400
450
500


DMC dlaDisturbance =0.8
y_{zad}(k)
u(k)
y(k)
y
k

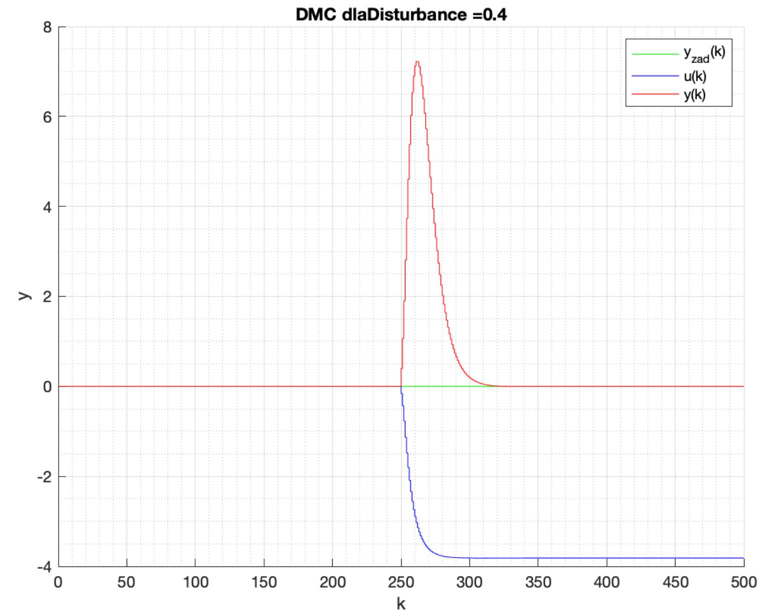

DMC dlaDisturbance =3
y_{zad}(k)
u(k)
y(k)
y
k


DMC dlaDisturbance =4.7
y
k
0
50
100
150
200
250
300
350
400
450
500
-50
0
50
100
y_zad(k)
u(k)
y(k)

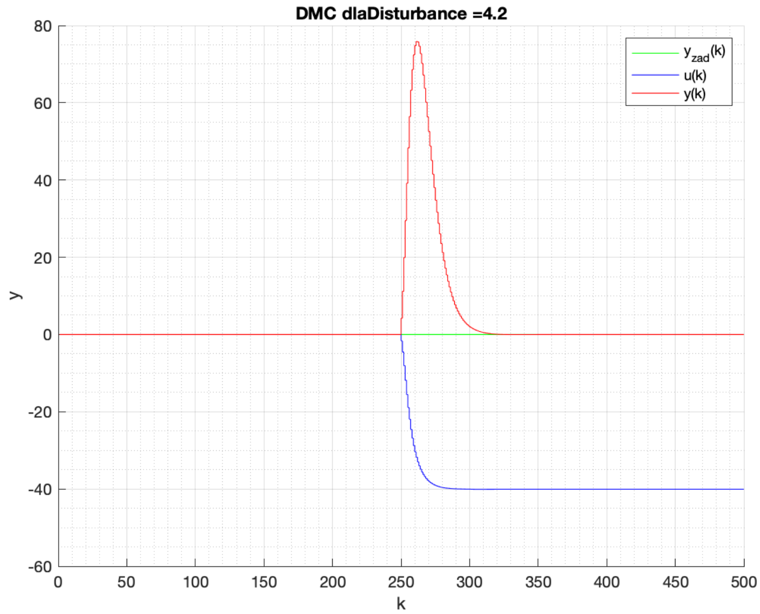

DMC dlaDisturbance =0.1
y
k
0
50
100
150
200
250
300
350
400
450
500
-1
-0.5
0
0.5
1
1.5
2
y_zad(k)
u(k)
y(k)

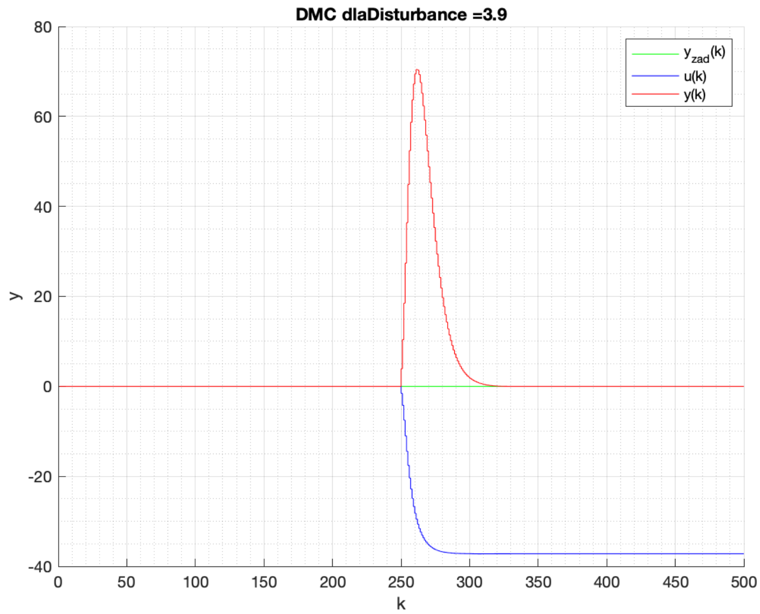


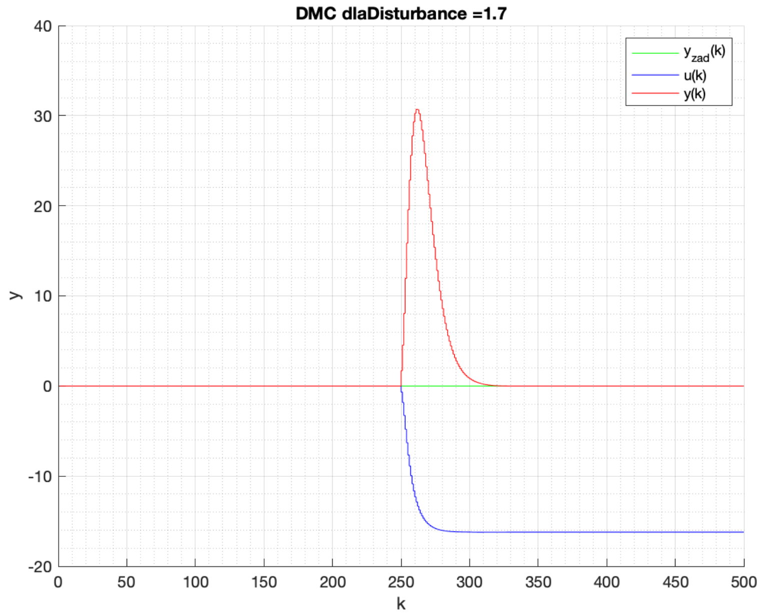
DMC dlaDisturbance =3.5
y
k
$y_{zad}(k)$
u(k)
y(k)

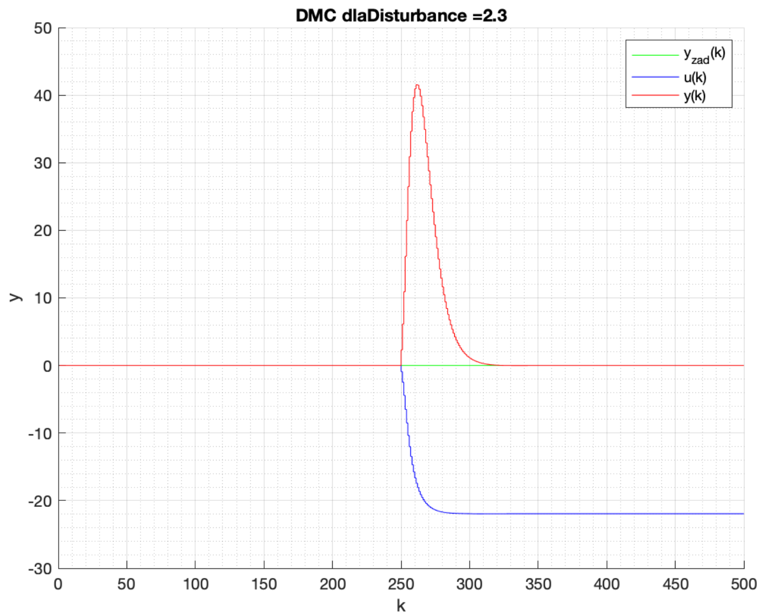


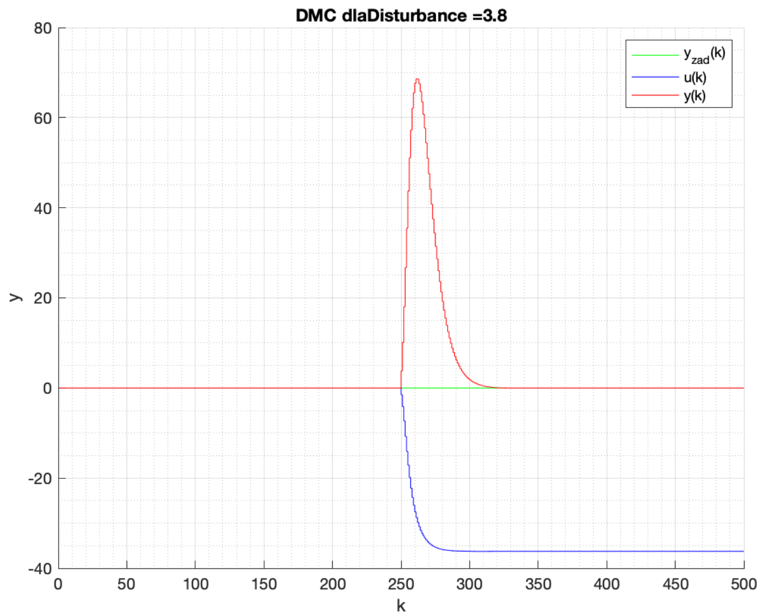
DMC dlaDisturbance =0.4
y
k
$y_{zad}(k)$
u(k)
y(k)

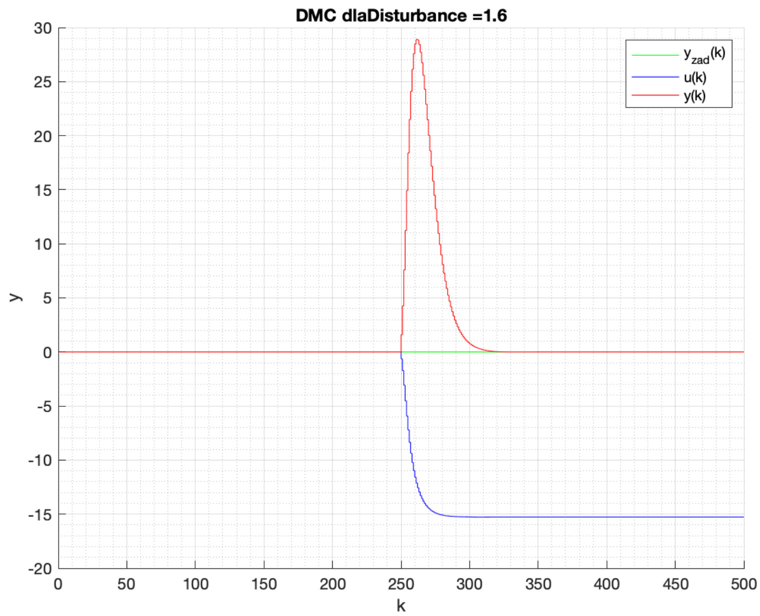

DMC dlaDisturbance =4.2
y
k
$y_{zad}(k)$
u(k)
y(k)

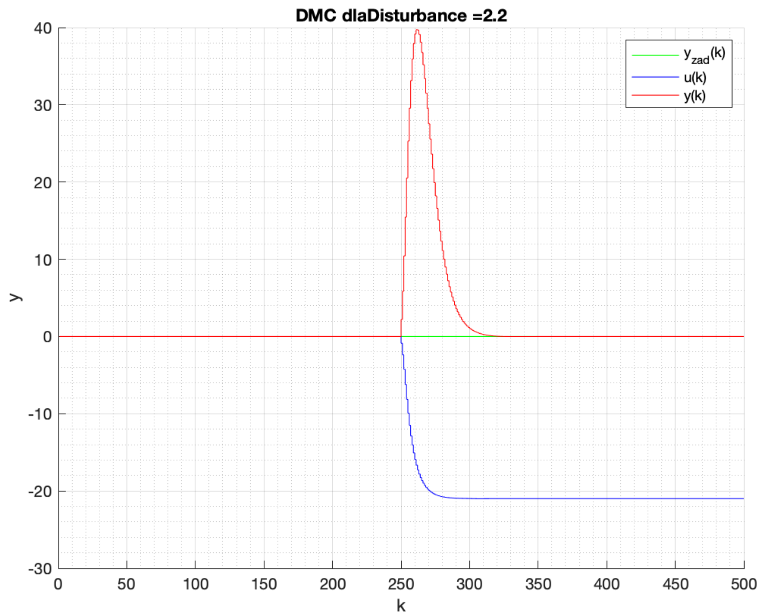

DMC dlaDisturbance =3.9
y
k
$y_{zad}(k)$
u(k)
y(k)

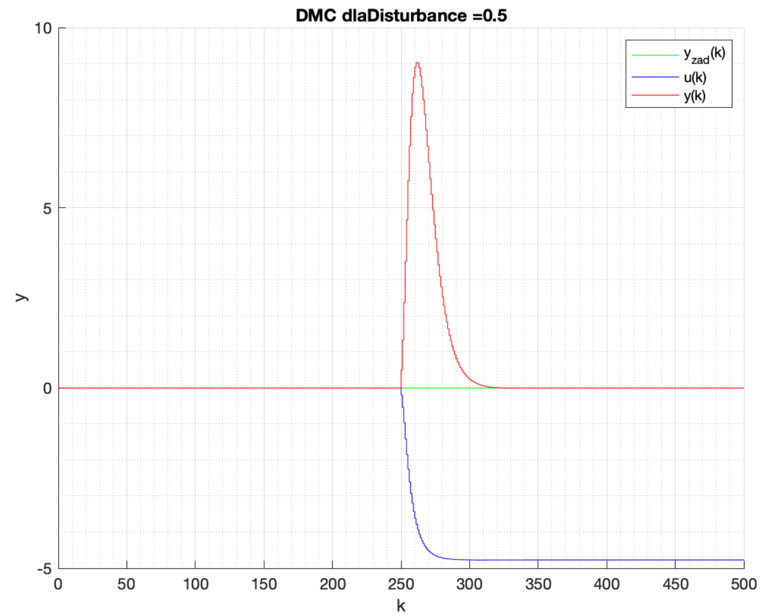

DMC dlaDisturbance =1.7
y_zad(k)
u(k)
y(k)
y
k

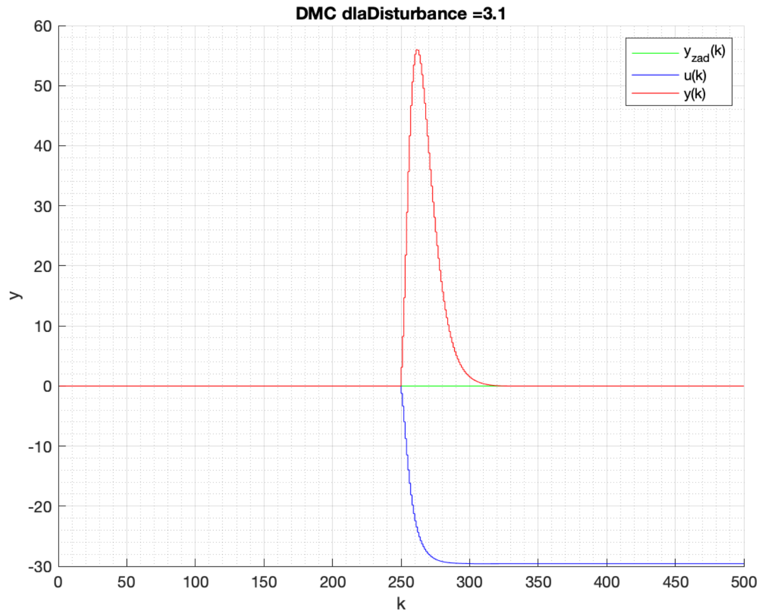

DMC dlaDisturbance =2.3
y_zad(k)
u(k)
y(k)
y
k

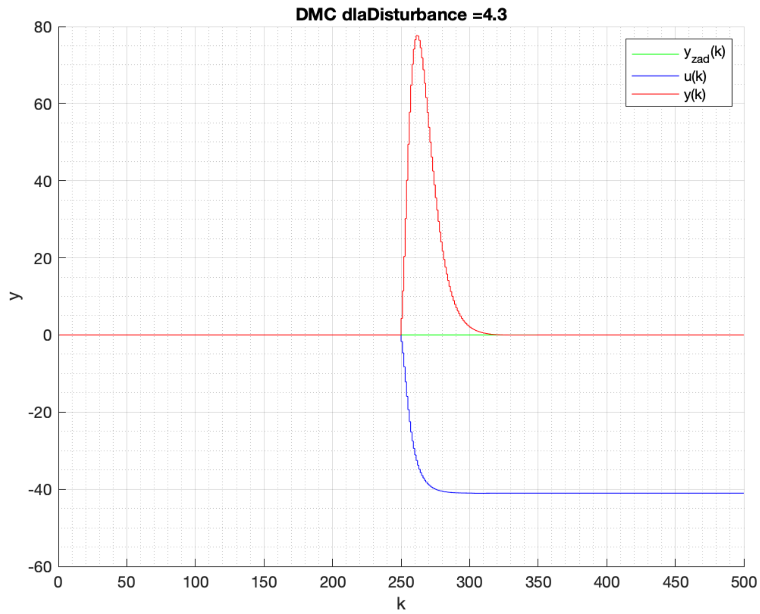

DMC dlaDisturbance =3.8
y
k
$y_{zad}(k)$
u(k)
y(k)
80
60
40
20
0
-20
-40
0
50
100
150
200
250
300
350
400
450
500

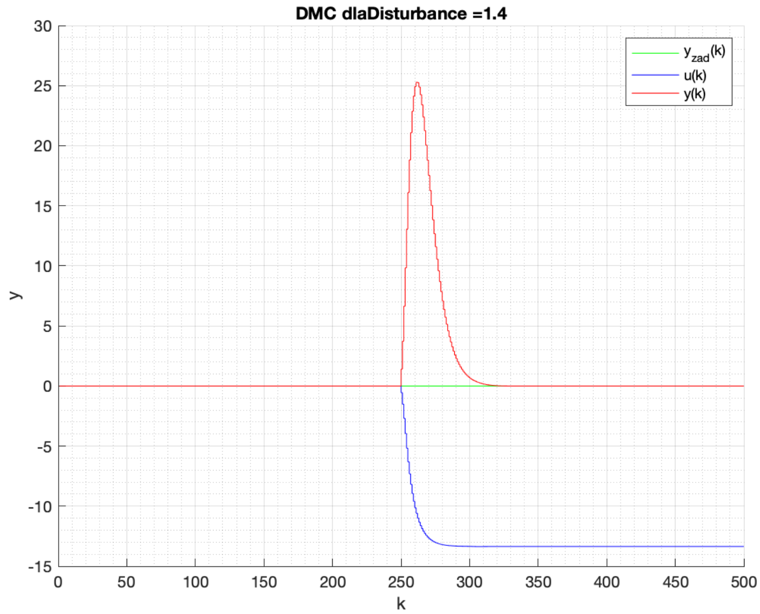

DMC dlaDisturbance =1.6
y
k
$y_{zad}(k)$
u(k)
y(k)
30
25
20
15
10
5
0
-5
-10
-15
-20
0
50
100
150
200
250
300
350
400
450
500

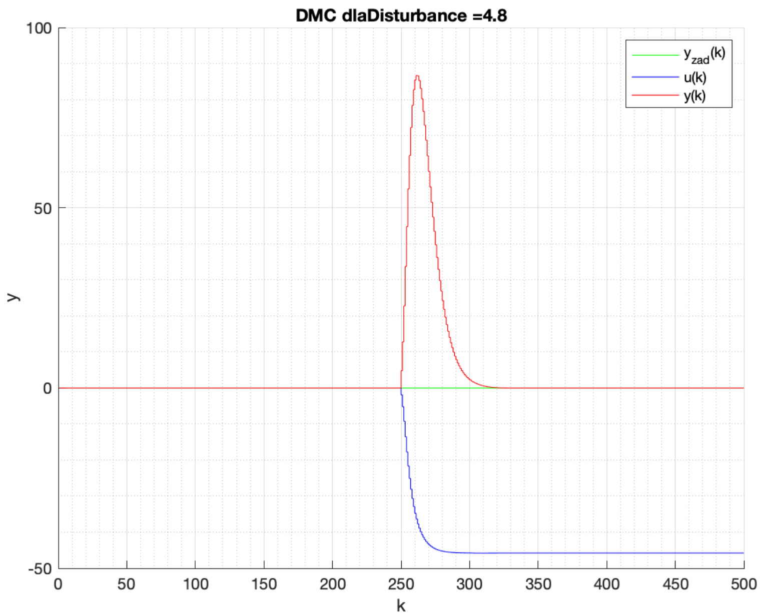

DMC dlaDisturbance =2.2
$y_{zad}(k)$
u(k)
y(k)
y
k
40
30
20
10
0
-10
-20
-30
0
50
100
150
200
250
300
350
400
450
500

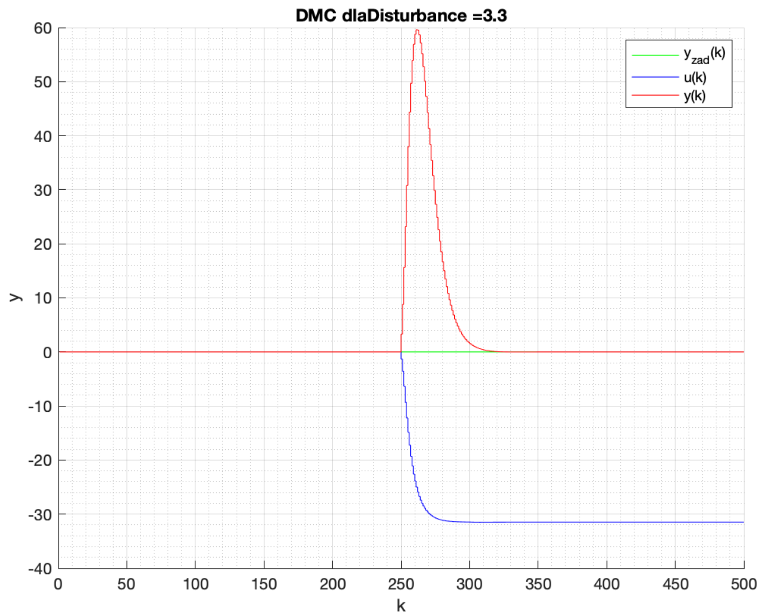

DMC dlaDisturbance =0.5
$y_{zad}(k)$
u(k)
y(k)
y
k
10
5
0
-5
0
50
100
150
200
250
300
350
400
450
500

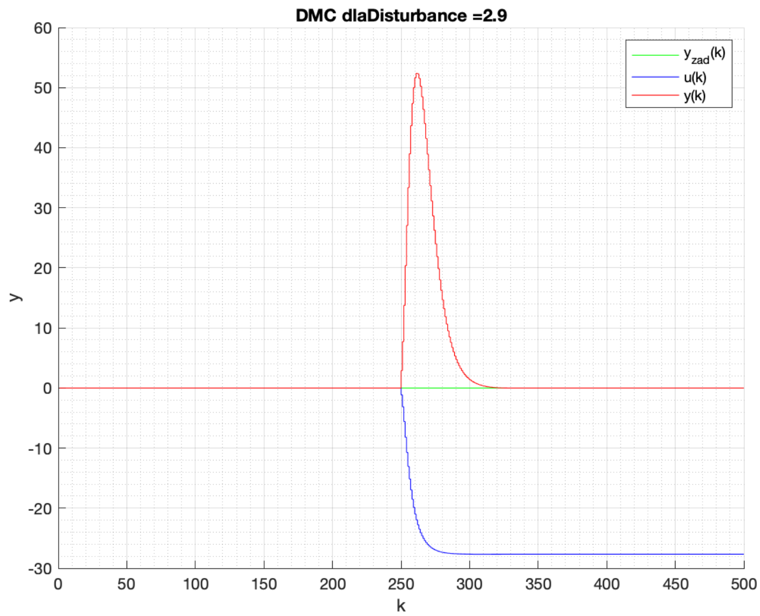

DMC dlaDisturbance =3.1
y_{zad}(k)
u(k)
y(k)
y
k
60
50
40
30
20
10
0
-10
-20
-30
0
50
100
150
200
250
300
350
400
450
500

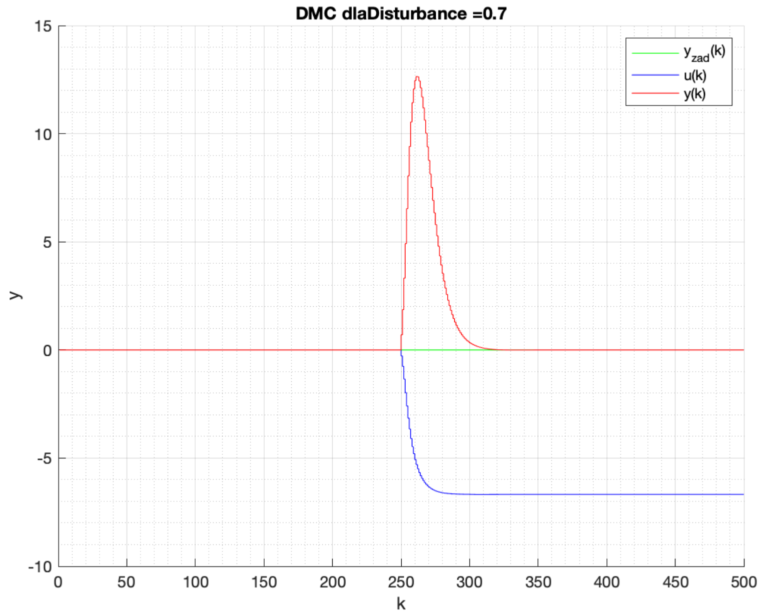

DMC dlaDisturbance =4.3
y_{zad}(k)
u(k)
y(k)
y
k
80
60
40
20
0
-20
-40
-60
0
50
100
150
200
250
300
350
400
450
500

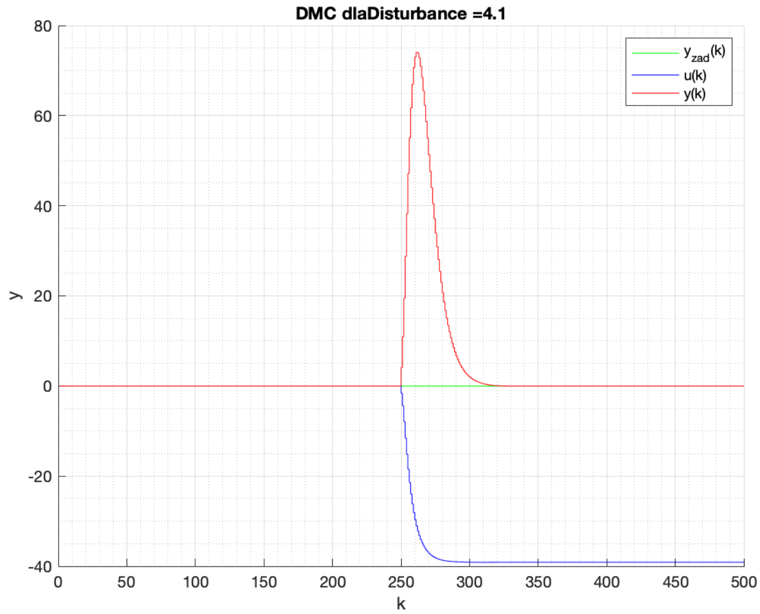

DMC dlaDisturbance =1.4
y
k
$y_{zad}(k)$
u(k)
y(k)
30
25
20
15
10
5
0
-5
-10
-15
0
50
100
150
200
250
300
350
400
450
500

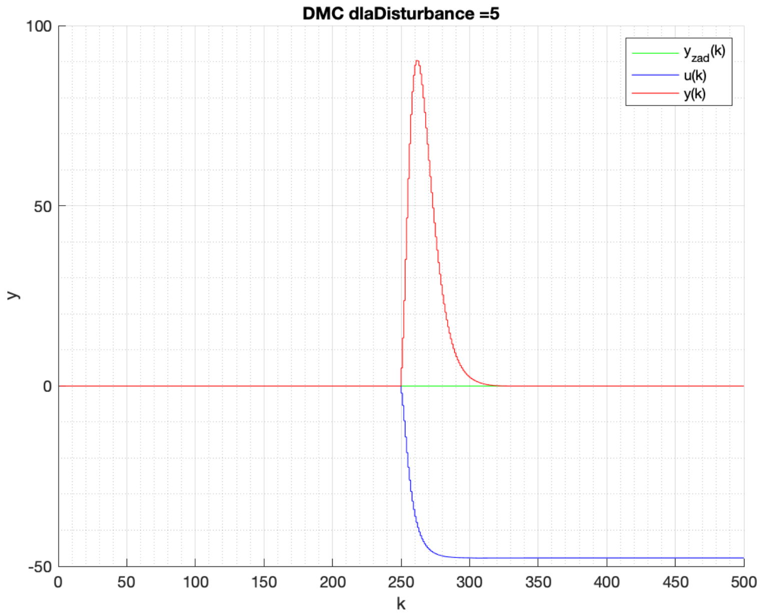

DMC dlaDisturbance =4.8
y
k
$y_{zad}(k)$
u(k)
y(k)
100
50
0
-50
0
50
100
150
200
250
300
350
400
450
500

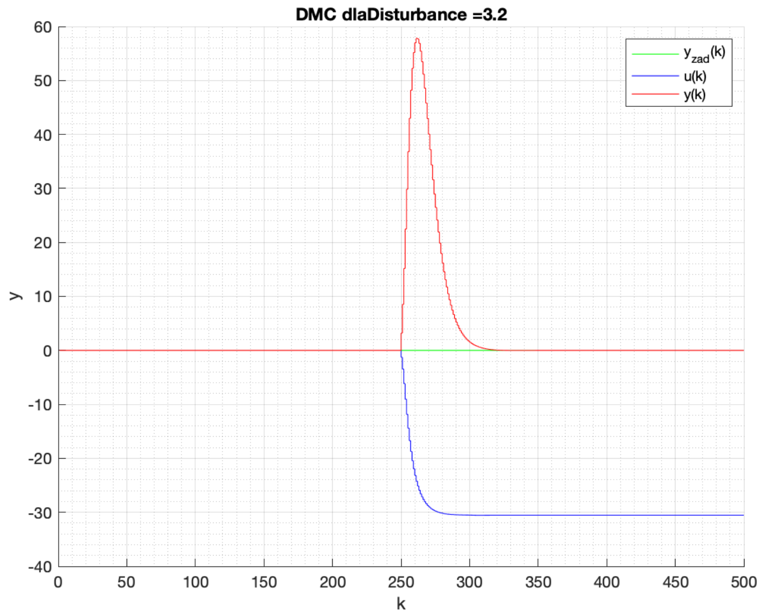

DMC dlaDisturbance =3.3
y
k
$y_{zad}(k)$
u(k)
y(k)
60
50
40
30
20
10
0
-10
-20
-30
-40
0
50
100
150
200
250
300
350
400
450
500

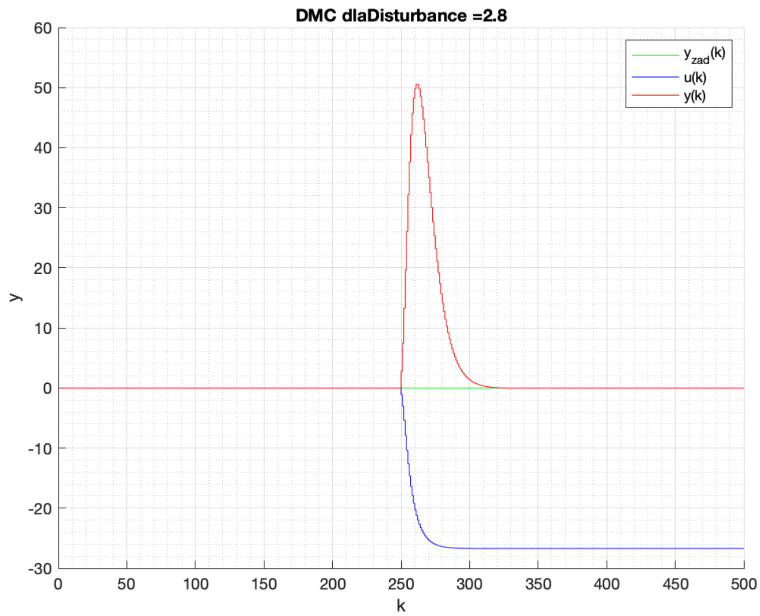

DMC dlaDisturbance =2.9
y
k
$y_{zad}(k)$
u(k)
y(k)
60
50
40
30
20
10
0
-10
-20
-30
0
50
100
150
200
250
300
350
400
450
500

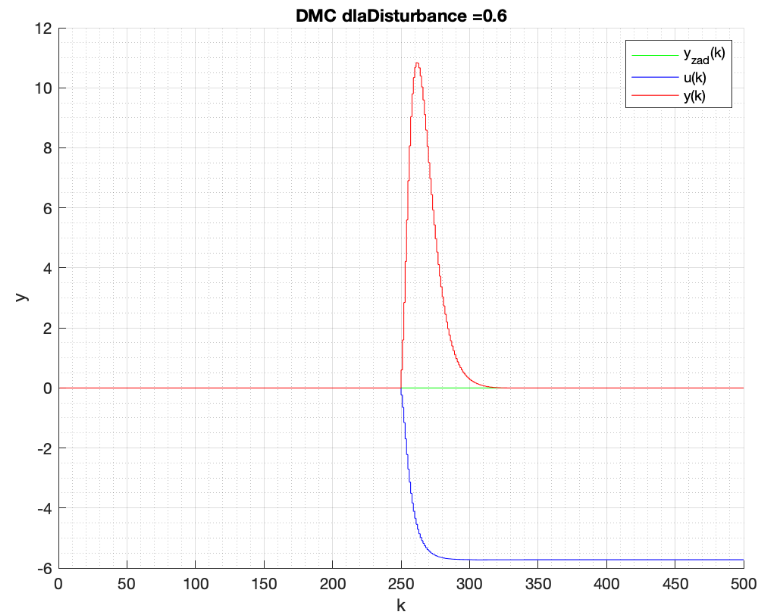

DMC dlaDisturbance =0.7
$y_{zad}(k)$
u(k)
y(k)
y
k

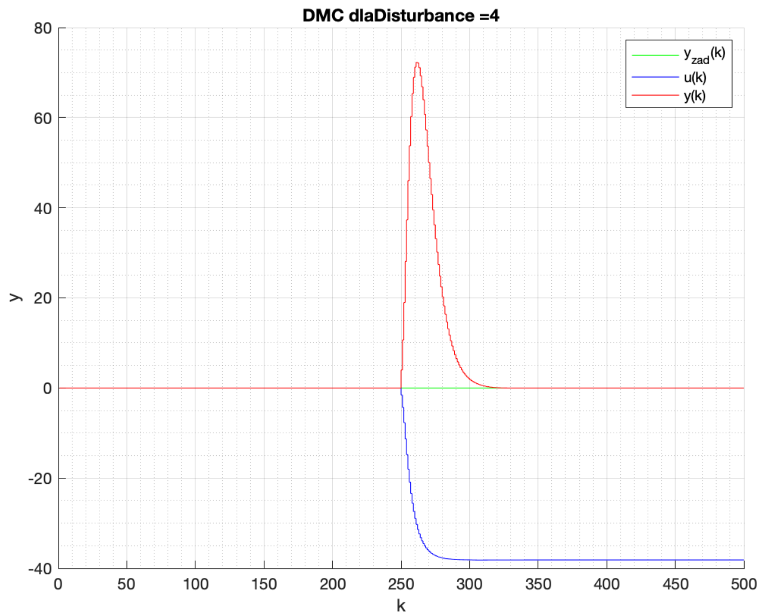

DMC dlaDisturbance =4.1
$y_{zad}(k)$
u(k)
y(k)
y
k

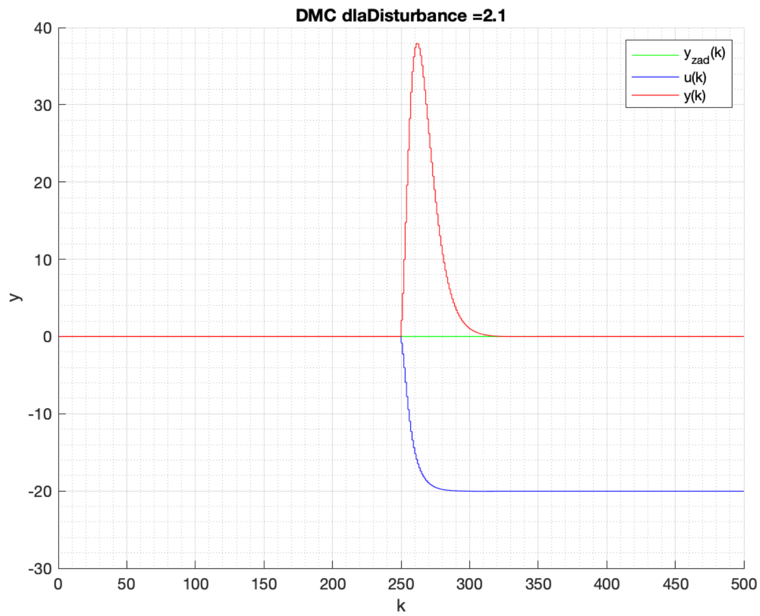

DMC dlaDisturbance =5
y
k
$y_{zad}(k)$
u(k)
y(k)

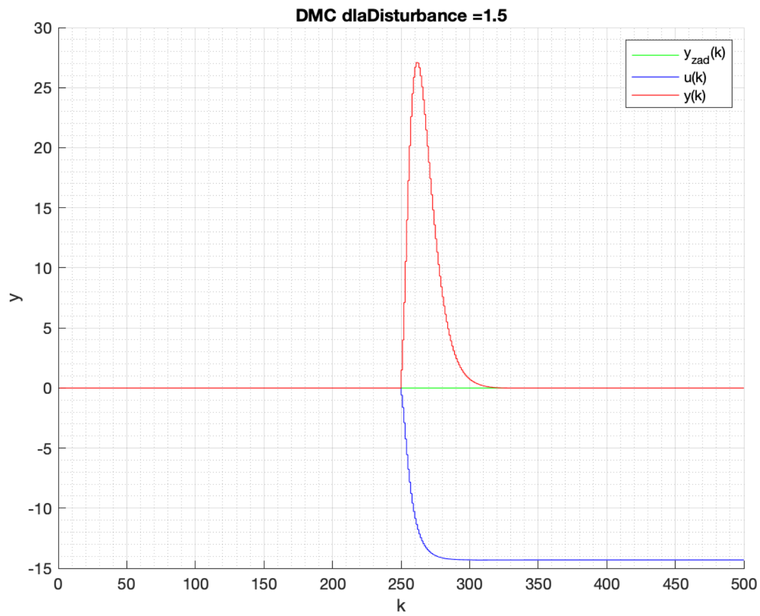

DMC dlaDisturbance =3.2
y
k
$y_{zad}(k)$
u(k)
y(k)

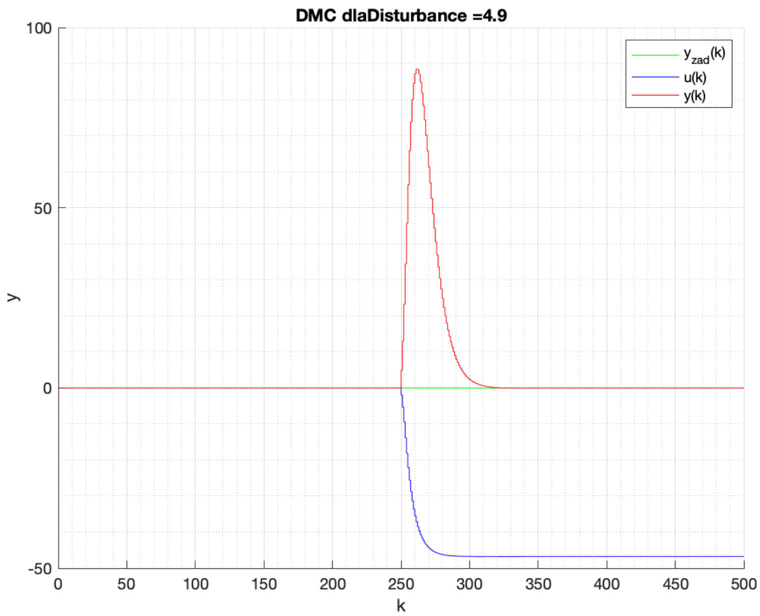

DMC dlaDisturbance =2.8
y
k
$y_{zad}(k)$
u(k)
y(k)

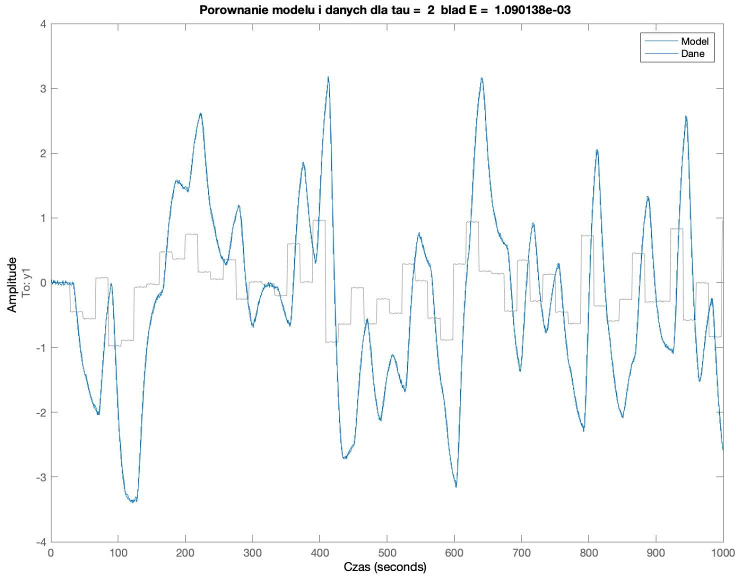

DMC dlaDisturbance =0.6
y
k
$y_{zad}(k)$
u(k)
y(k)

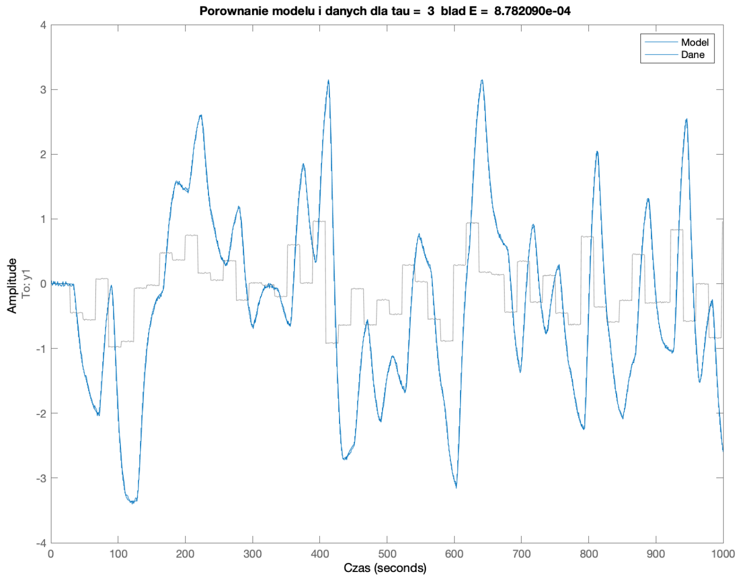

DMC dlaDisturbance =4
y
k
$y_{zad}(k)$
u(k)
y(k)

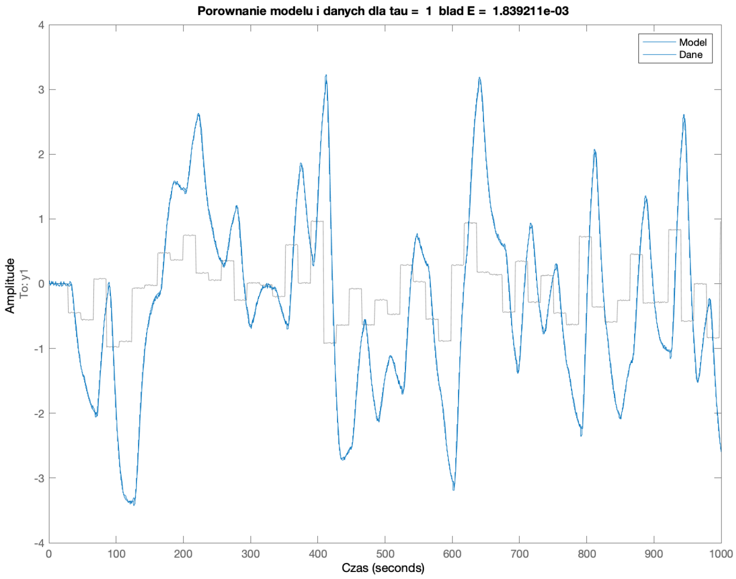

DMC dlaDisturbance =2.1
y
k
$y_{zad}(k)$
u(k)
y(k)

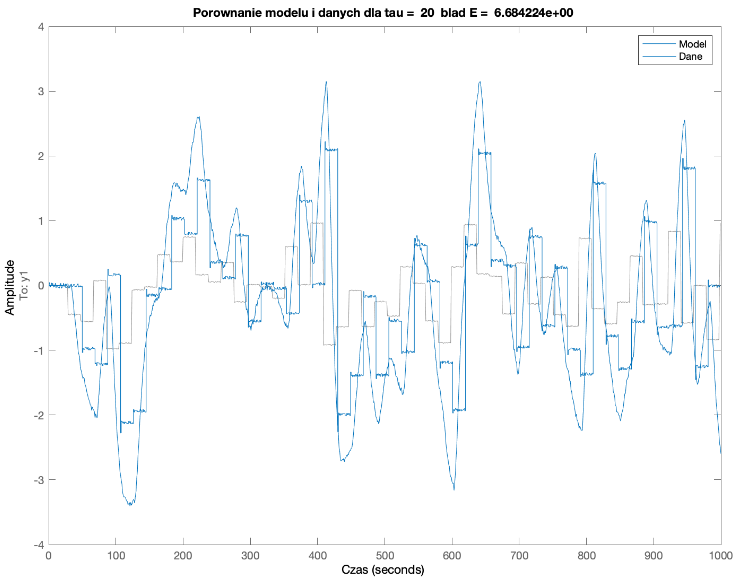

DMC dlaDisturbance =1.5
y
k
$y_{zad}(k)$
u(k)
y(k)

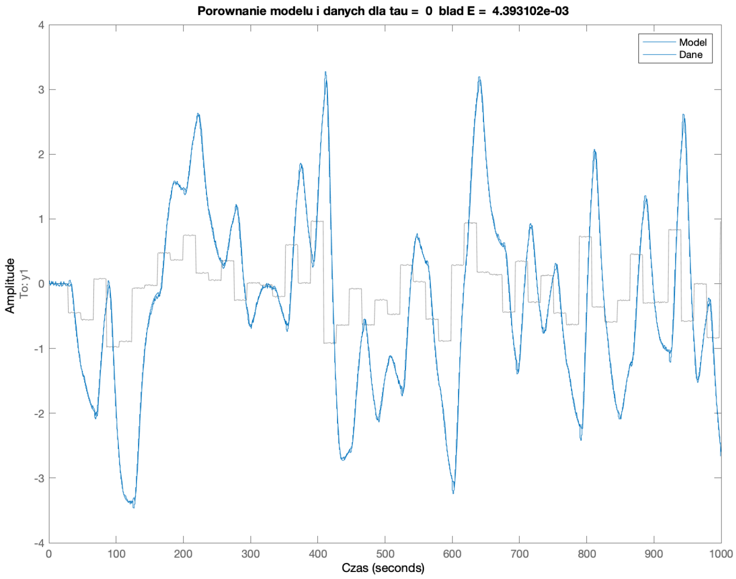

DMC dlaDisturbance =4.9
y
k
$y_{zad}(k)$
u(k)
y(k)

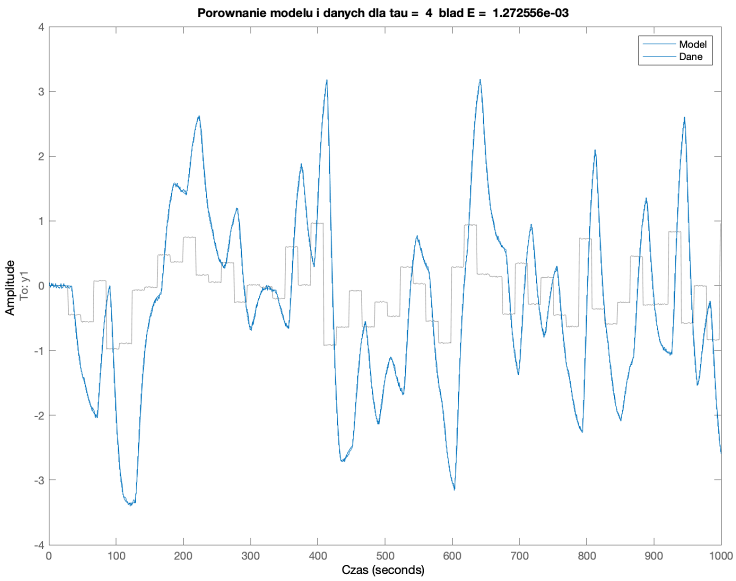

Porownanie modelu i danych dla tau = 2 blad E = 1.090138e-03
Amplitude
To: y1
Czas (seconds)
Model
Dane

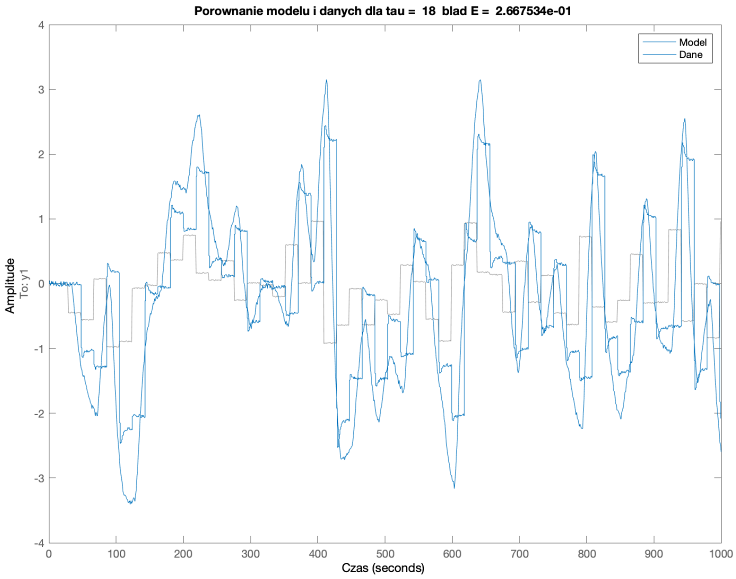

Porownanie modelu i danych dla tau = 3 blad E = 8.782090e-04
Amplitude
To: y1
Czas (seconds)
Model
Dane

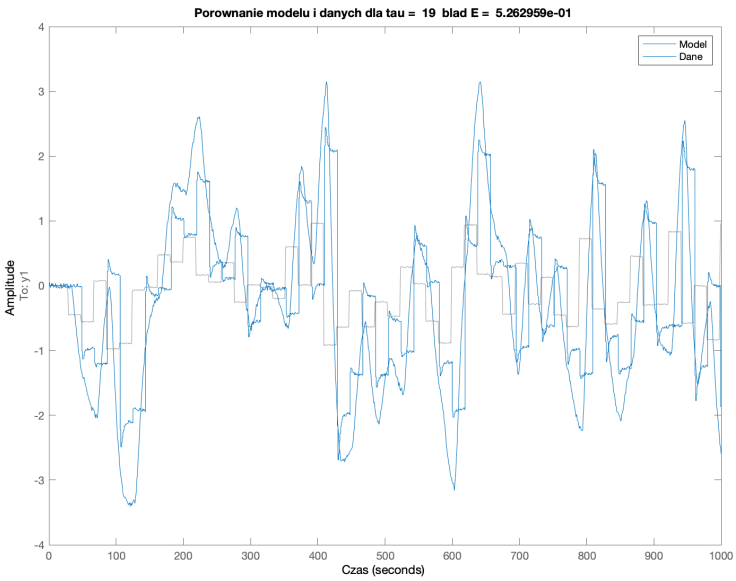

Porownanie modelu i danych dla tau = 1 blad E = 1.839211e-03
Model
Dane
Amplitude
To: y1
Czas (seconds)

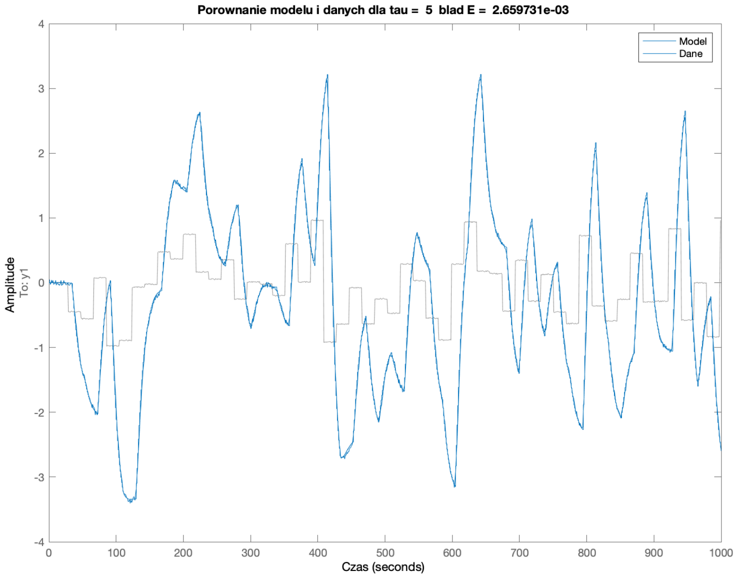

Porownanie modelu i danych dla tau = 20 blad E = 6.684224e+00
Model
Dane
Amplitude
To: y1
Czas (seconds)

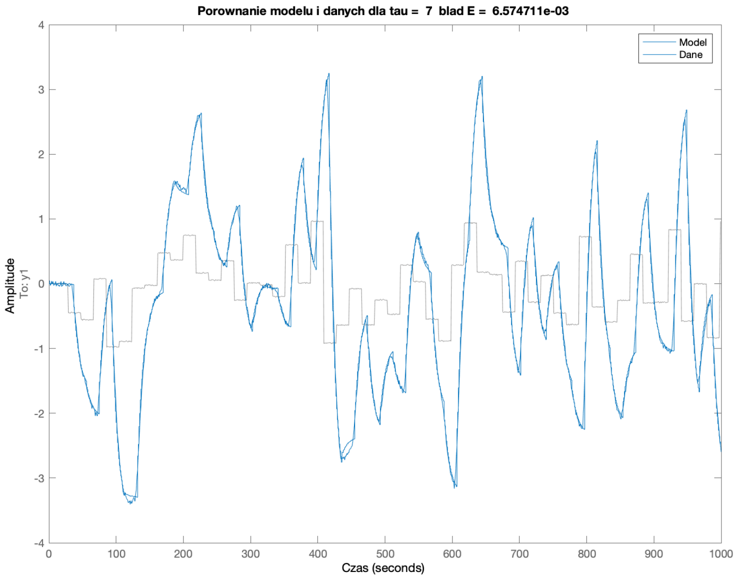

Porownanie modelu i danych dla tau = 0 blad E = 4.393102e-03
Model
Dane
Amplitude
To: y1
Czas (seconds)
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000

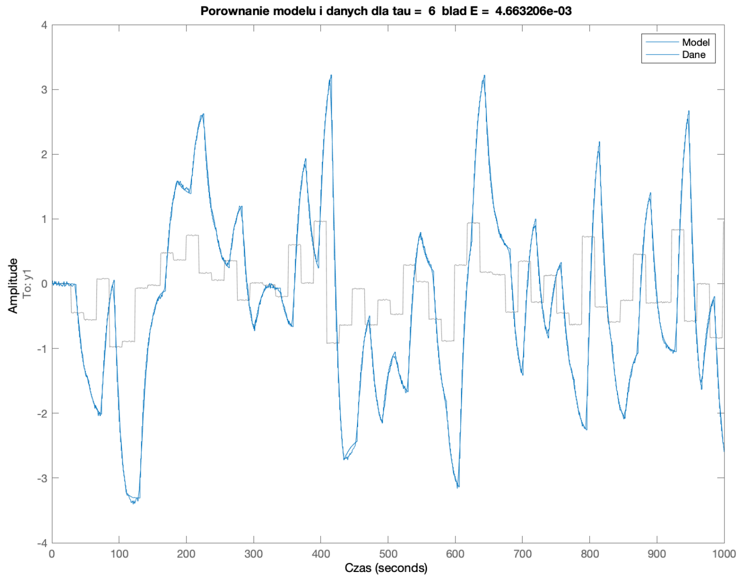

Porownanie modelu i danych dla tau = 4 blad E = 1.272556e-03
Model
Dane
Amplitude
To: y1
Czas (seconds)
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000


Porownanie modelu i danych dla tau = 18 blad E = 2.667534e-01
Model
Dane
Amplitude
To: y1
Czas (seconds)
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000

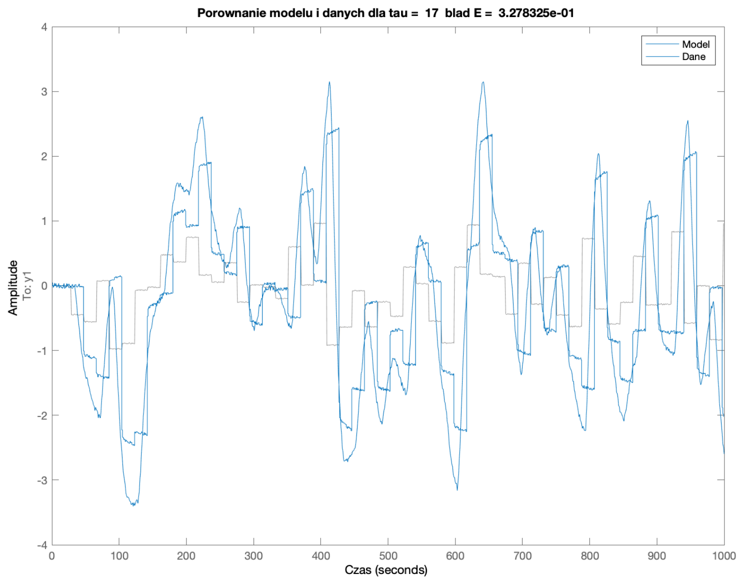

Porownanie modelu i danych dla tau = 19 blad E = 5.262959e-01
Model
Dane
Amplitude
To: y1
Czas (seconds)
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000


Porownanie modelu i danych dla tau = 5 blad E = 2.659731e-03
Model
Dane
Amplitude
To: y1
Czas (seconds)
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000

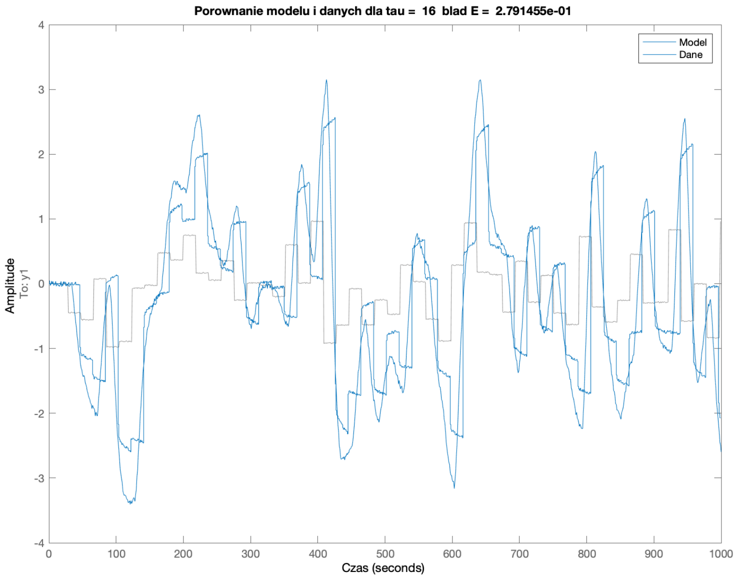

Porownanie modelu i danych dla tau = 7 blad E = 6.574711e-03
Model
Dane
Amplitude
To: y1
Czas (seconds)
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000

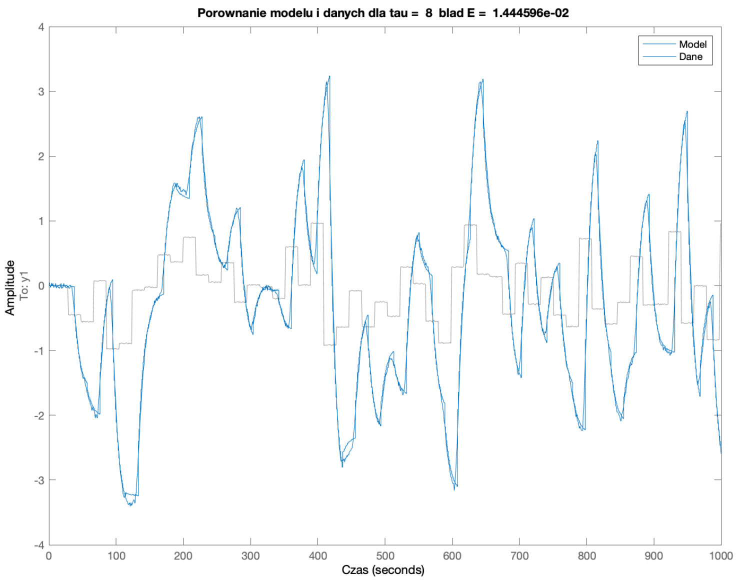


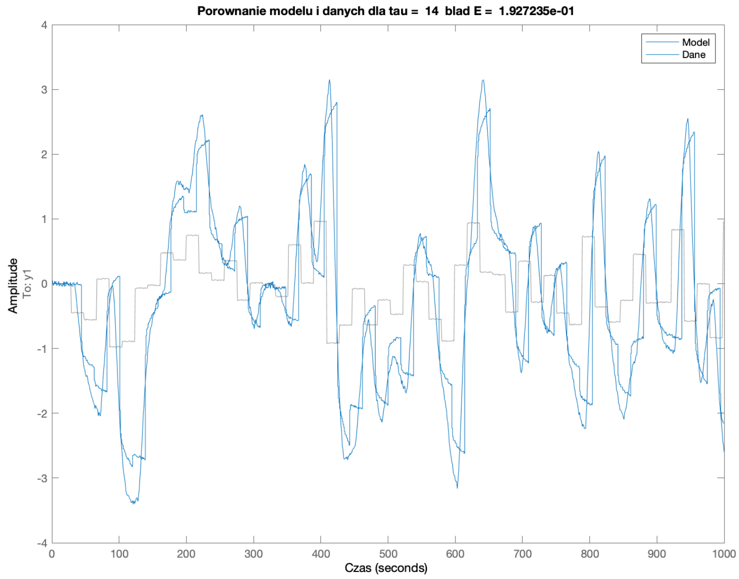
Porownanie modelu i danych dla tau = 6 blad E = 4.663206e-03
Model
Dane
Amplitude
To: y1
Czas (seconds)

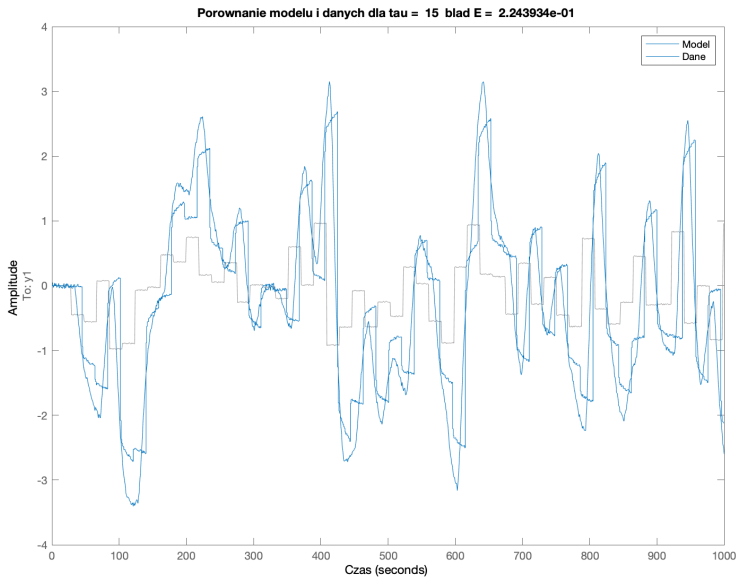


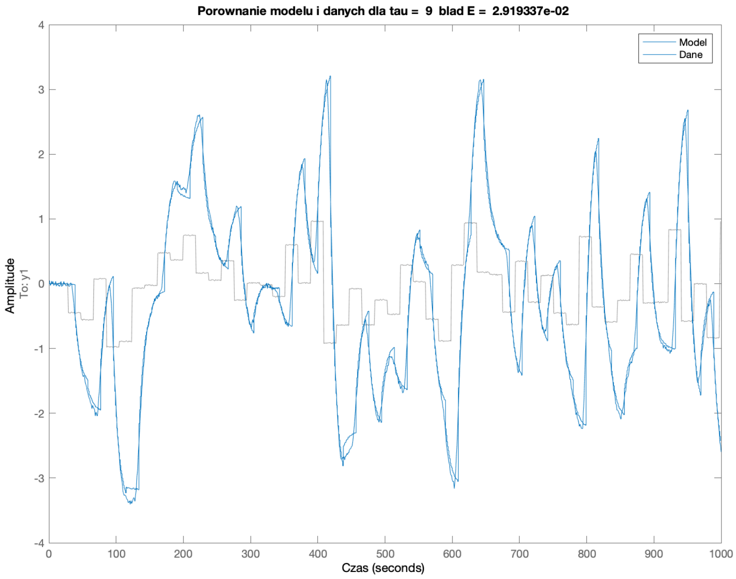
Porownanie modelu i danych dla tau = 17 blad E = 3.278325e-01
Model
Dane
Amplitude
To: y1
Czas (seconds)

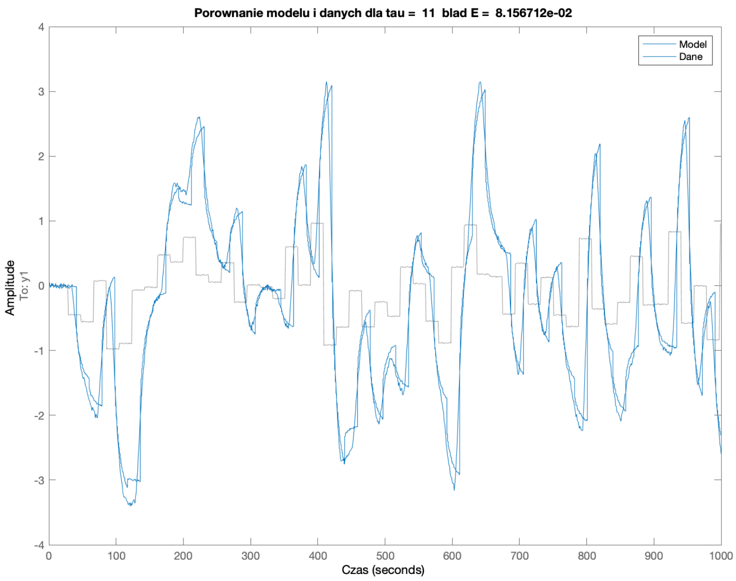

Porownanie modelu i danych dla tau = 16 blad E = 2.791455e-01
Model
Dane
Amplitude
To: y1
Czas (seconds)
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000

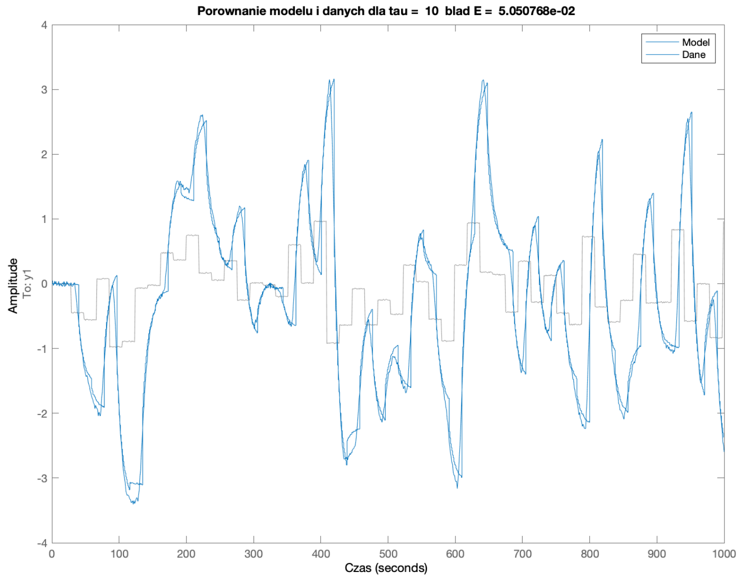

Porownanie modelu i danych dla tau = 8 blad E = 1.444596e-02
Model
Dane
Amplitude
To: y1
Czas (seconds)
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000

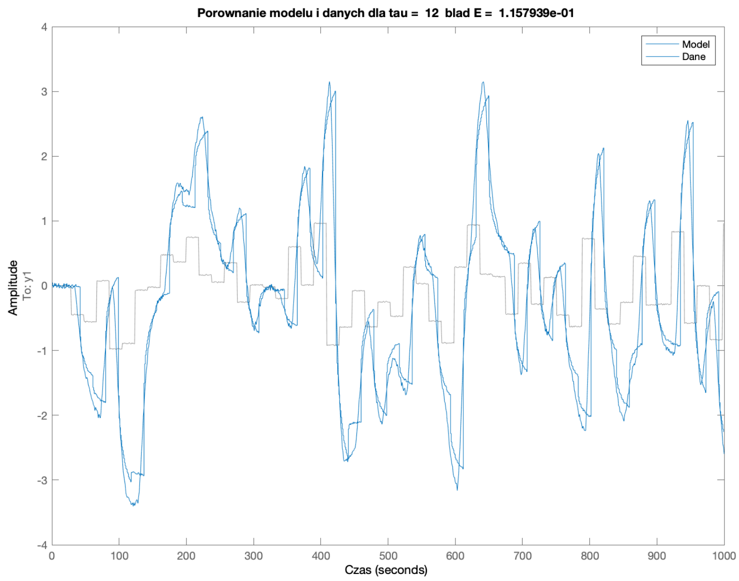

Porownanie modelu i danych dla tau = 14 blad E = 1.927235e-01
Model
Dane
Amplitude
To: y1
Czas (seconds)
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000

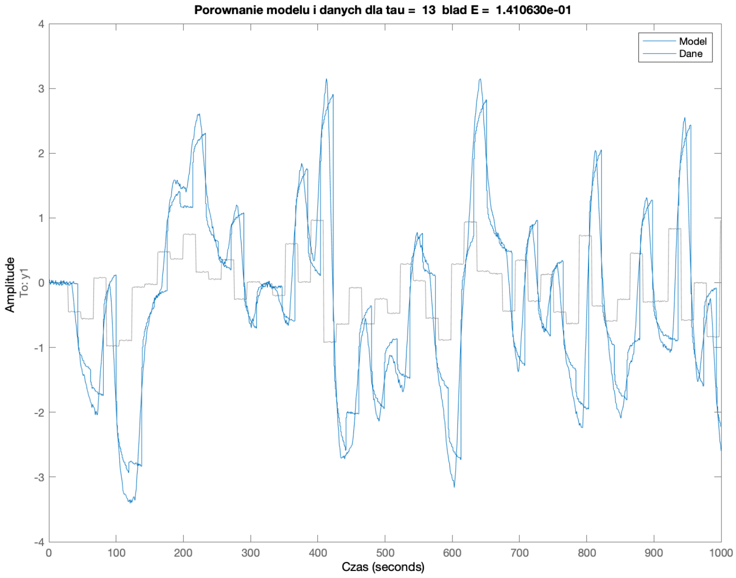

Porownanie modelu i danych dla tau = 15 blad E = 2.243934e-01
Model
Dane
Amplitude
To: y1
Czas (seconds)
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000

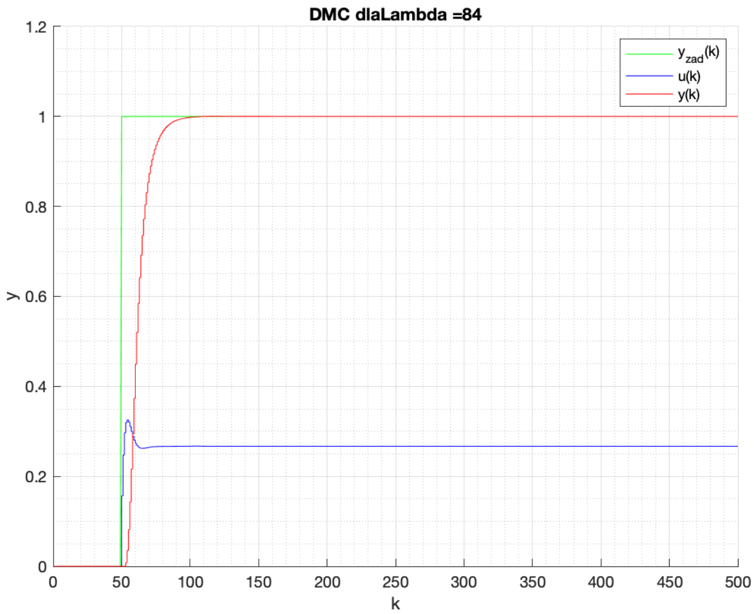

Porownanie modelu i danych dla tau = 9 blad E = 2.919337e-02
Amplitude
To: y1
Czas (seconds)
Model
Dane

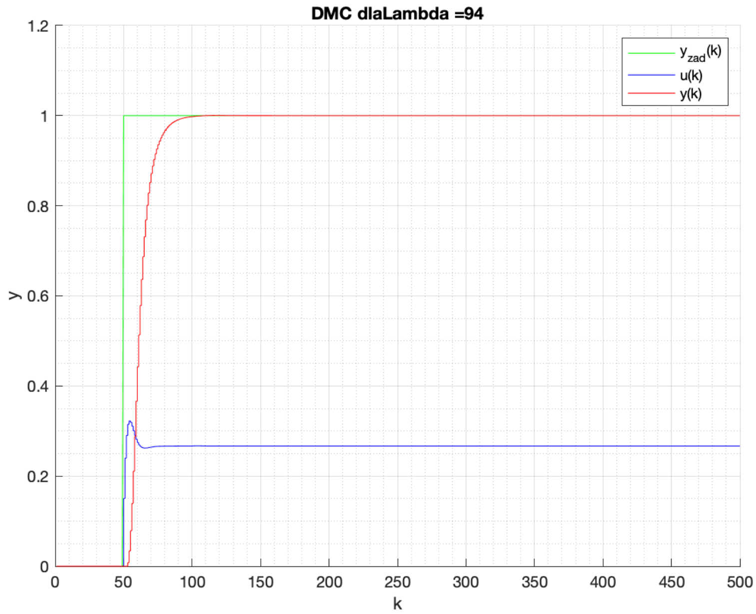

Porownanie modelu i danych dla tau = 11 blad E = 8.156712e-02
Amplitude
To: y1
Czas (seconds)
Model
Dane

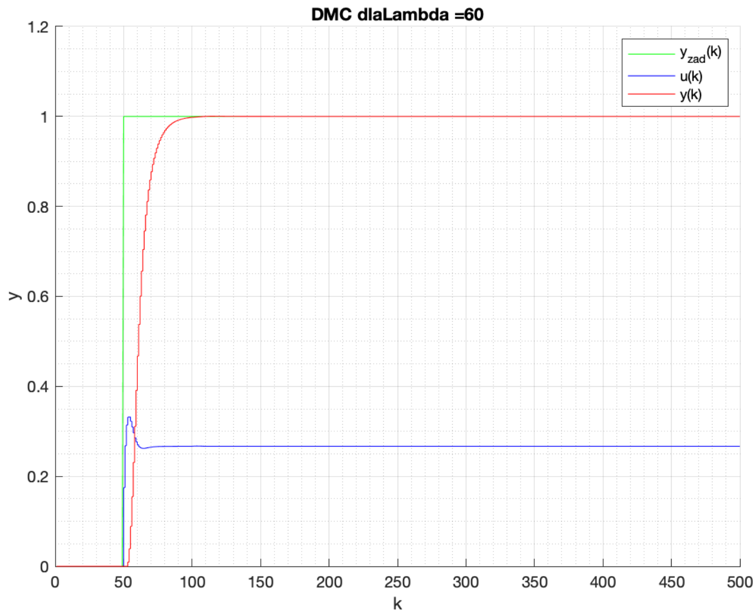

Porownanie modelu i danych dla tau = 10 blad E = 5.050768e-02
Model
Dane
Amplitude
To: y1
Czas (seconds)

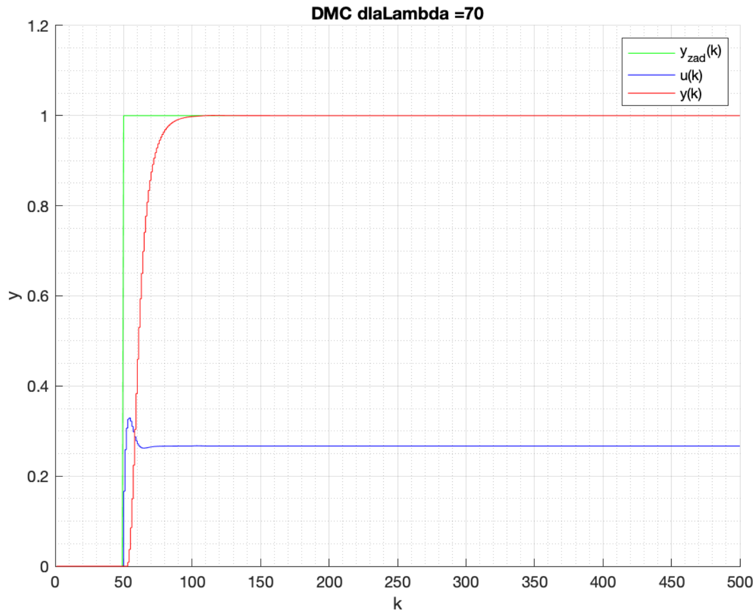

Porownanie modelu i danych dla tau = 12 blad E = 1.157939e-01
Model
Dane
Amplitude
To: y1
Czas (seconds)

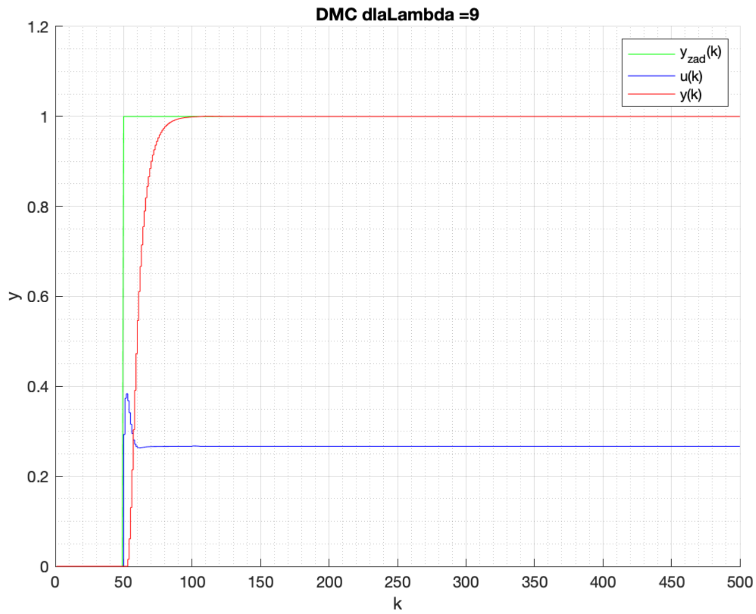

Porownanie modelu i danych dla tau = 13 blad E = 1.410630e-01
Model
Dane
Amplitude
To; y1
Czas (seconds)

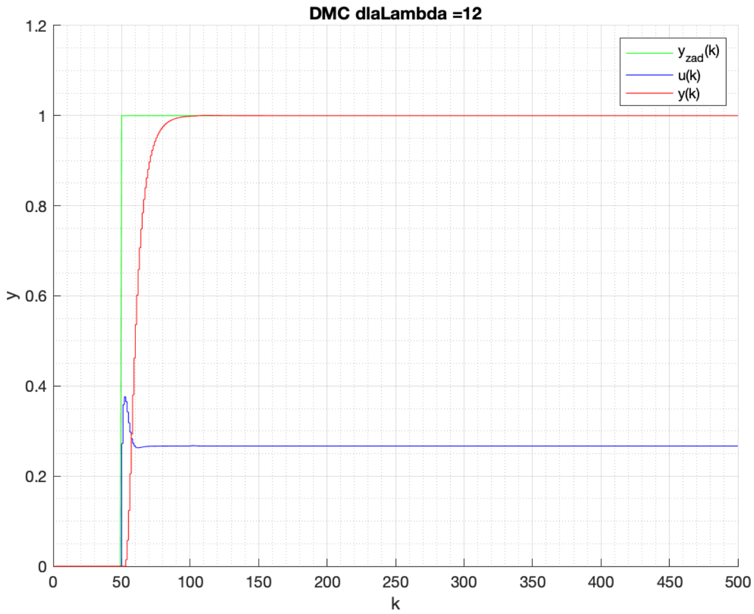

DMC dlaLambda =84
$y_{zad}(k)$
u(k)
y(k)
y
k

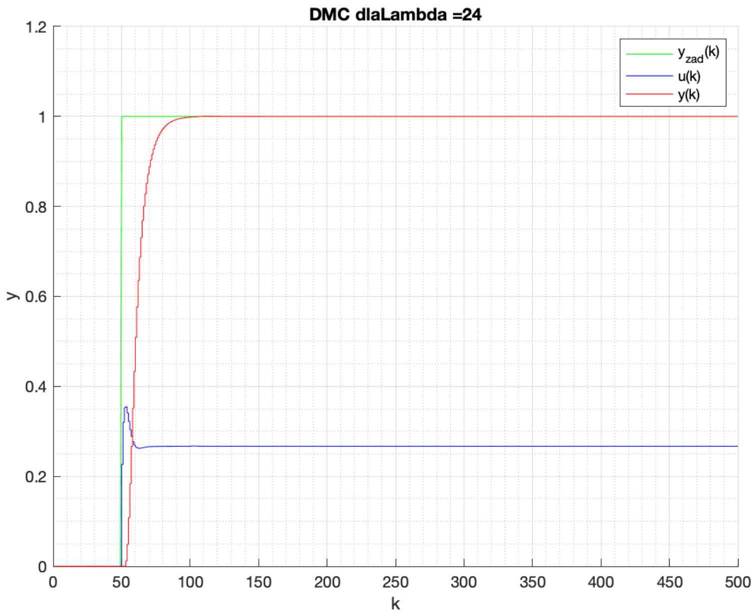

DMC dlaLambda =94
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
50
100
150
200
250
300
350
400
450
500

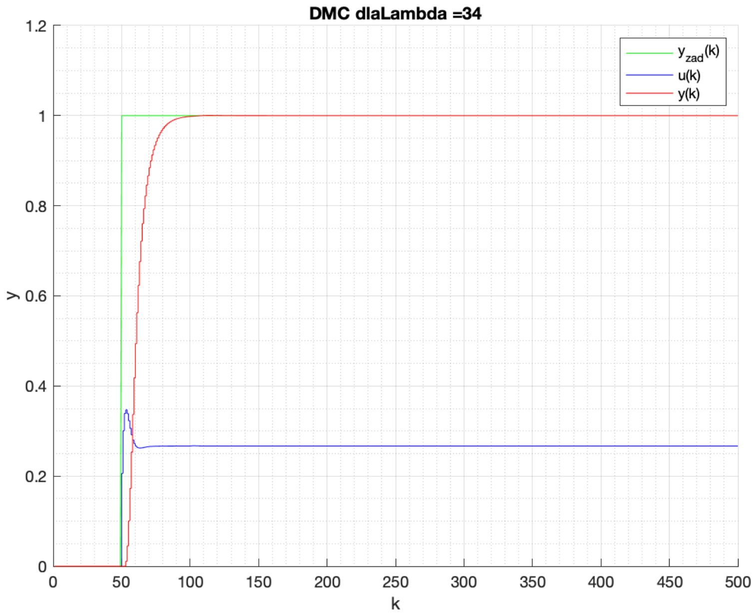

DMC dlaLambda =60
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
50
100
150
200
250
300
350
400
450
500

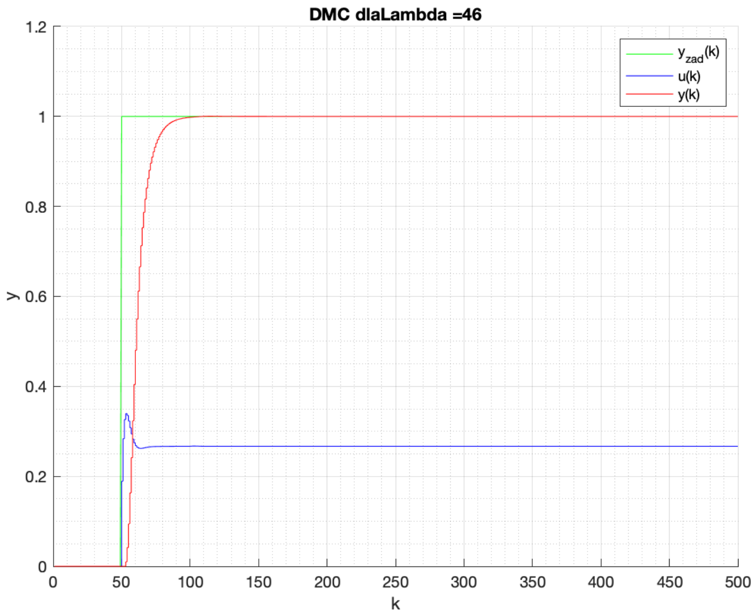

DMC dlaLambda =70
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

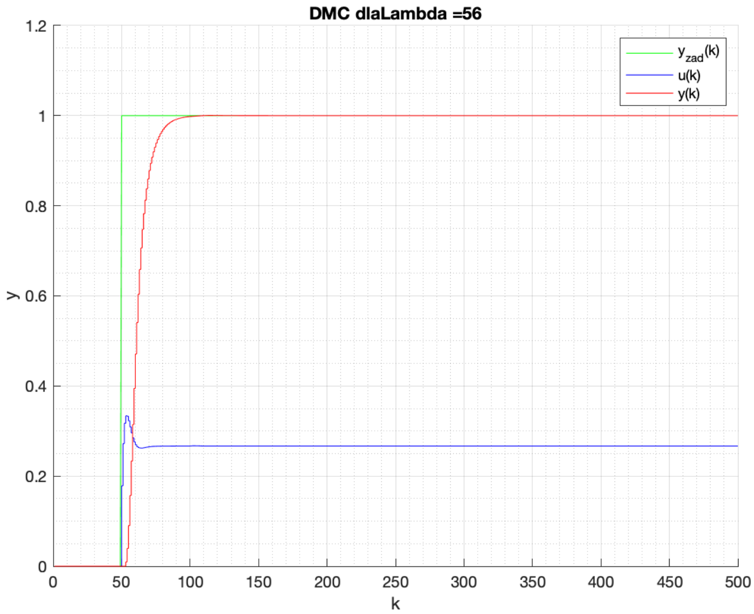

DMC dlaLambda =9
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

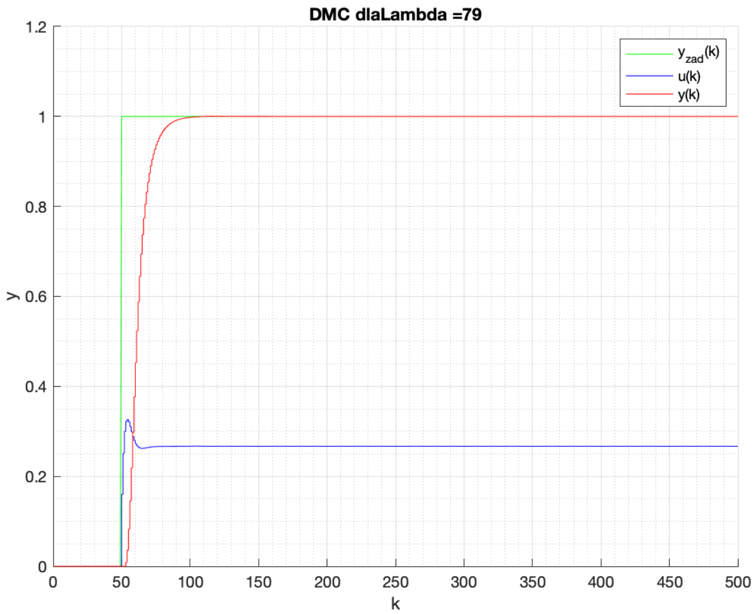

DMC dlaLambda =12
y
k
yzad(k)
u(k)
y(k)

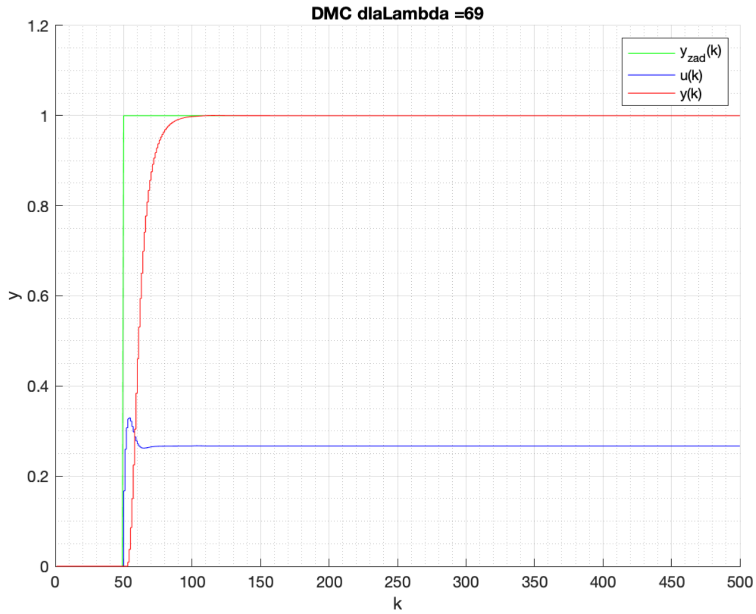

DMC dlaLambda =24
y
k
yzad(k)
u(k)
y(k)

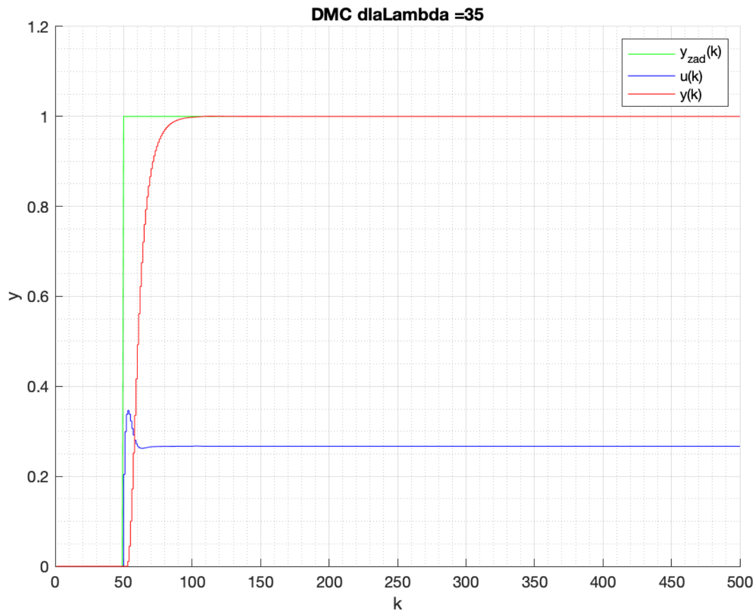

DMC dlaLambda =34
1.2
1
0.8
y 0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500
k
$y_{zad}(k)$
u(k)
y(k)

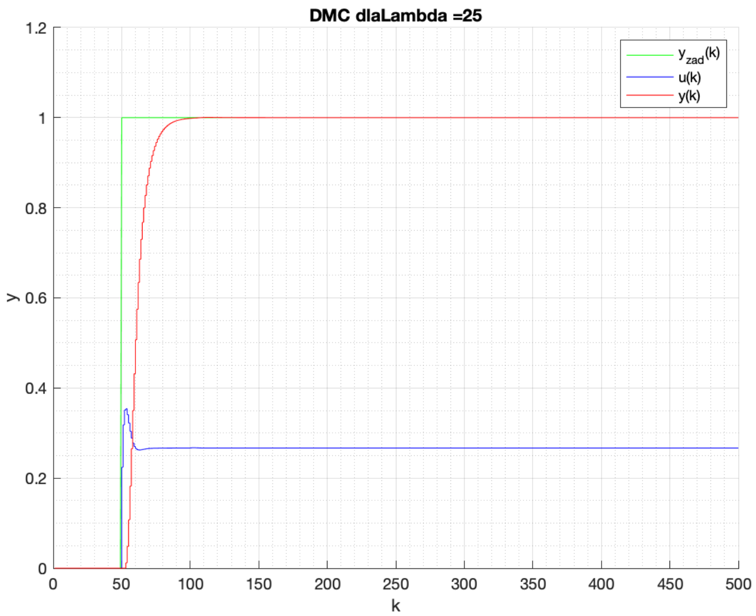

DMC dlaLambda =46
1.2
1
0.8
y 0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500
k
$y_{zad}(k)$
u(k)
y(k)

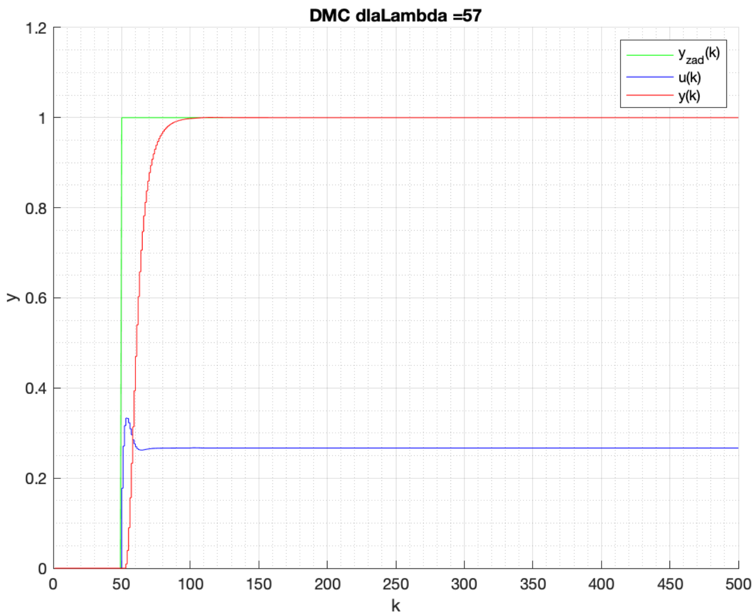

DMC dlaLambda =56
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

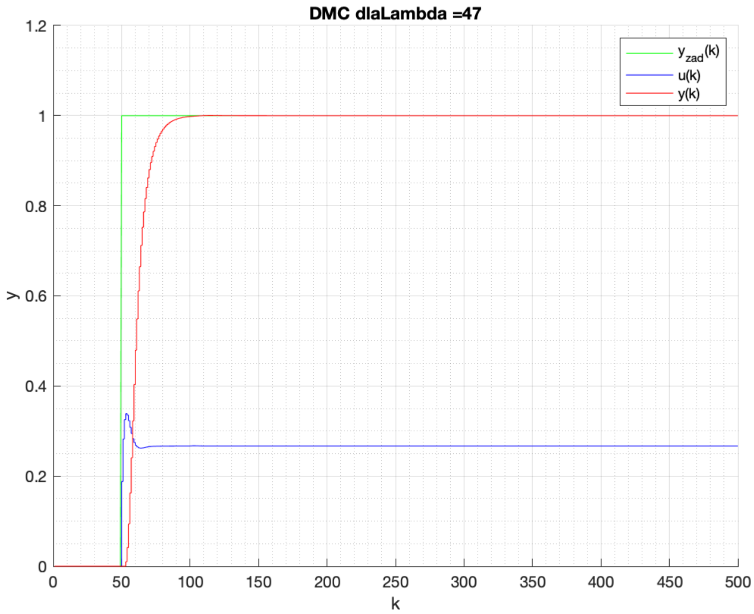

DMC dlaLambda =79
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

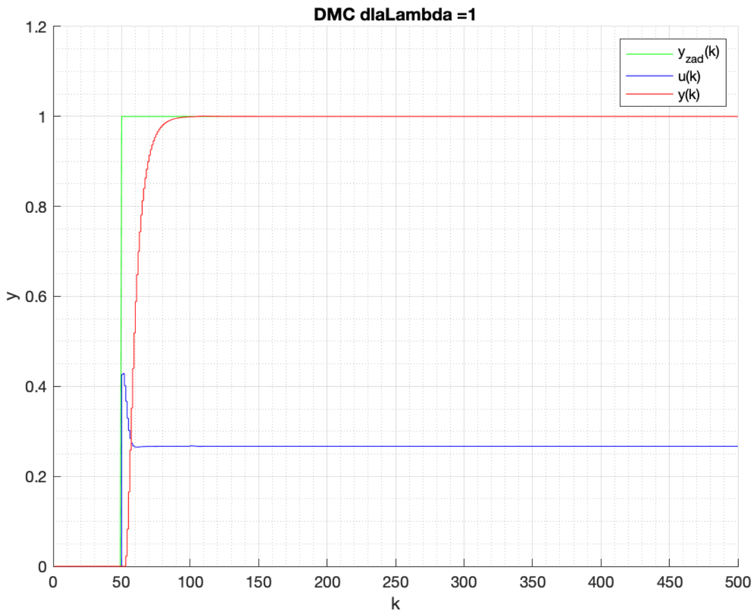

DMC dlaLambda =69
y
k
y_{zad}(k)
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

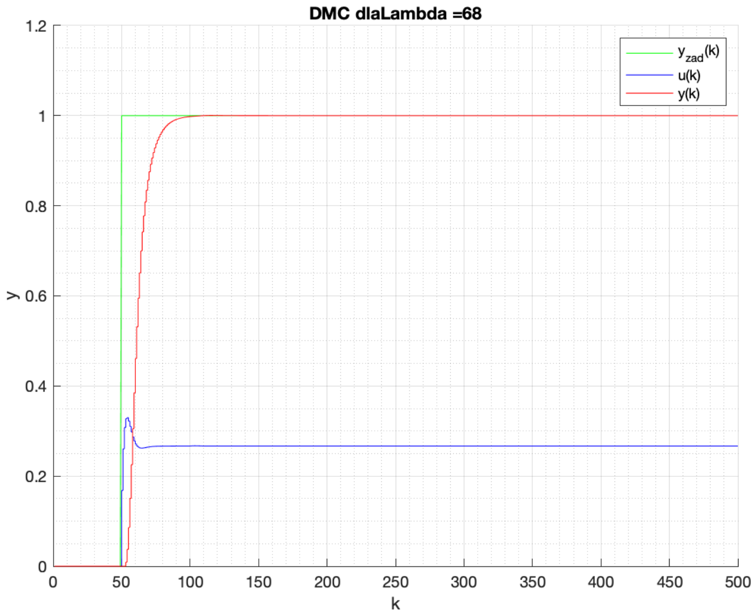

DMC dlaLambda =35
y
k
y_{zad}(k)
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

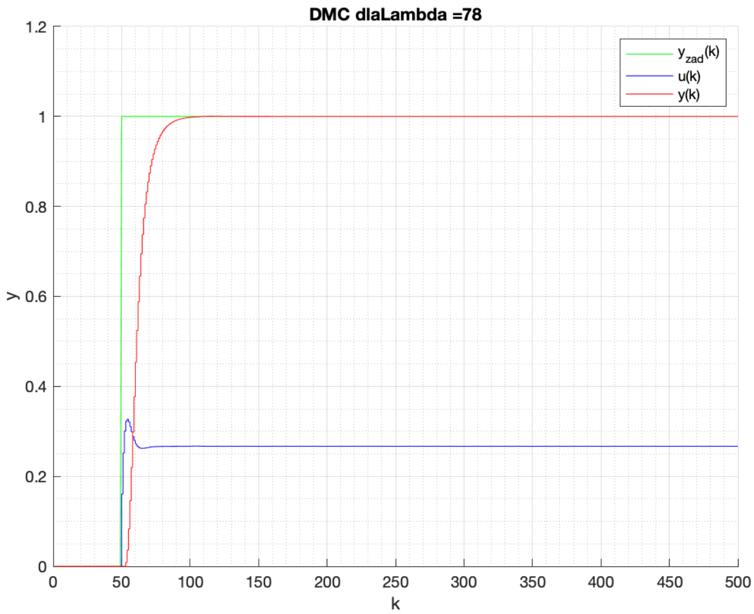

DMC dlaLambda =25
y
k
yzad(k)
u(k)
y(k)

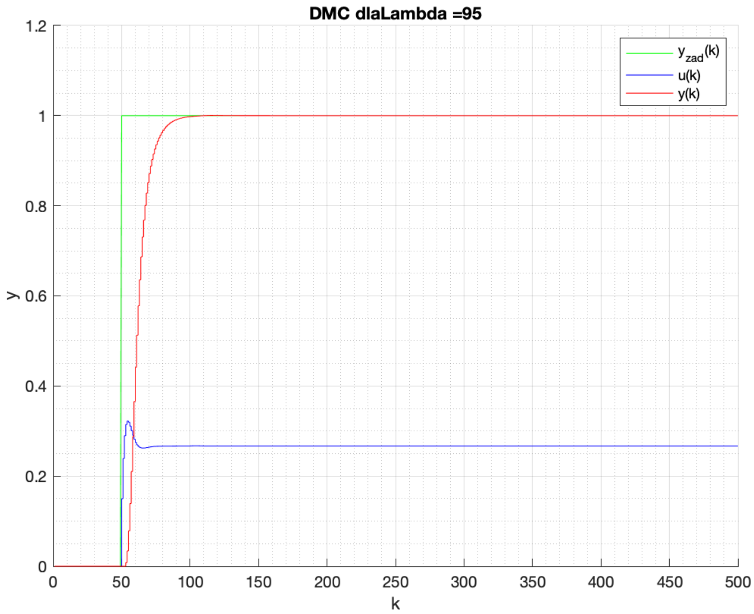

DMC dlaLambda =57
y
k
yzad(k)
u(k)
y(k)

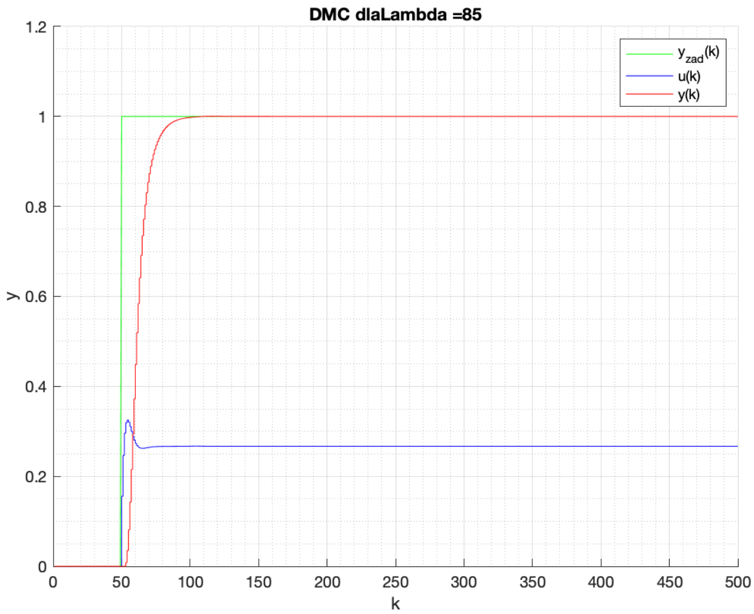

DMC dlaLambda =47
y
k
yzad(k)
u(k)
y(k)
0
50
100
150
200
250
300
350
400
450
500
0.2
0.4
0.6
0.8
1
1.2

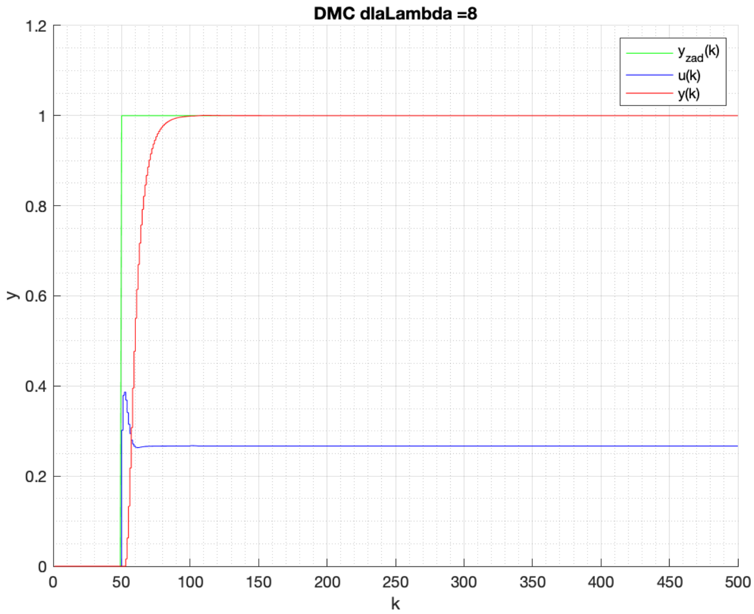

DMC dlaLambda =1
y
k
yzad(k)
u(k)
y(k)
0
50
100
150
200
250
300
350
400
450
500
0.2
0.4
0.6
0.8
1
1.2

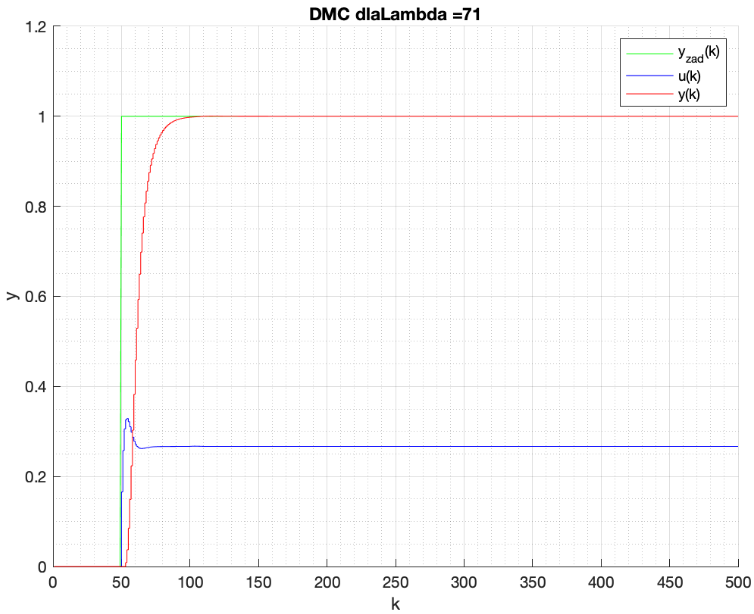

DMC dlaLambda =68
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

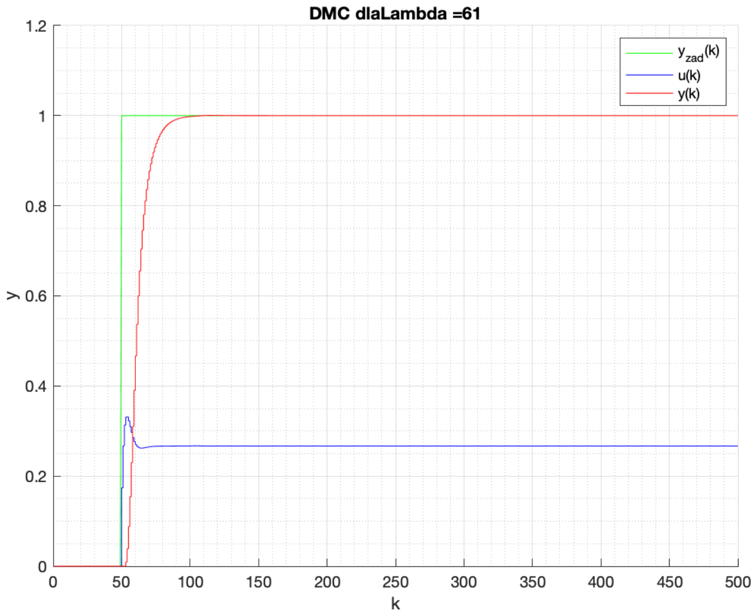

DMC dlaLambda =78
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

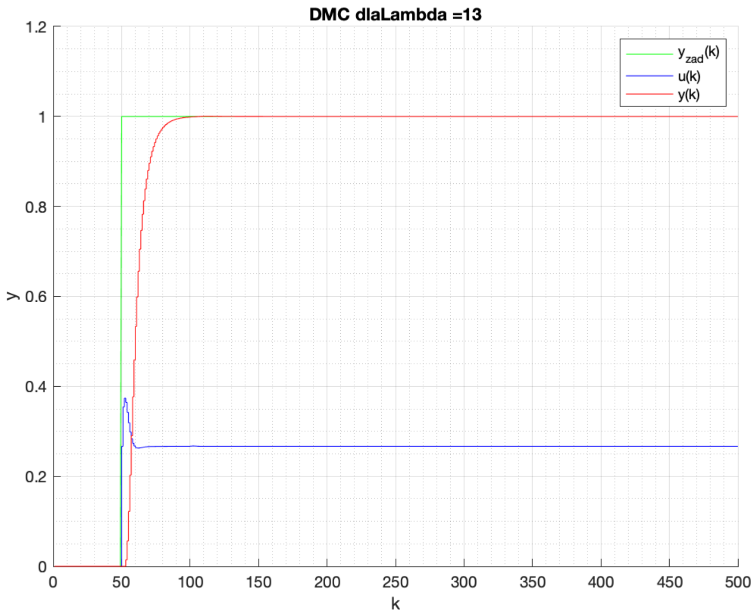

DMC dlaLambda =95
y
k
y_zad(k)
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

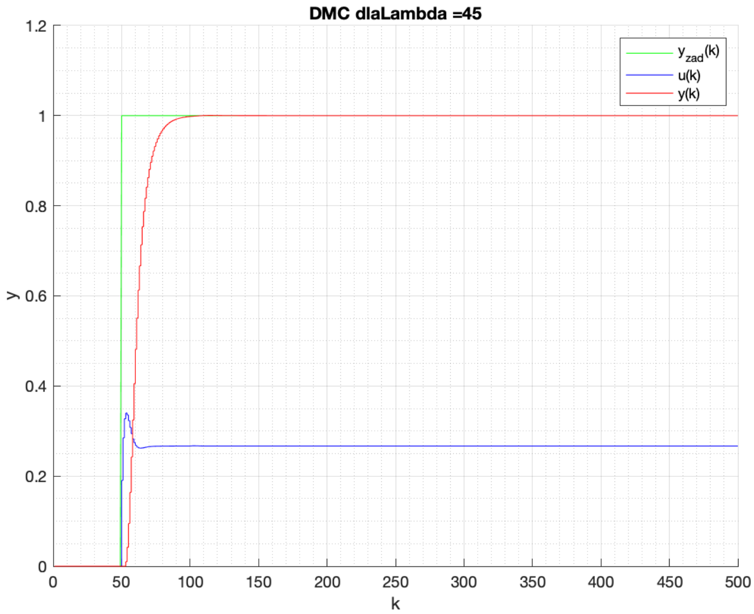

DMC dlaLambda =85
y
k
y_zad(k)
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500


DMC dlaLambda =8
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
50
100
150
200
250
300
350
400
450
500

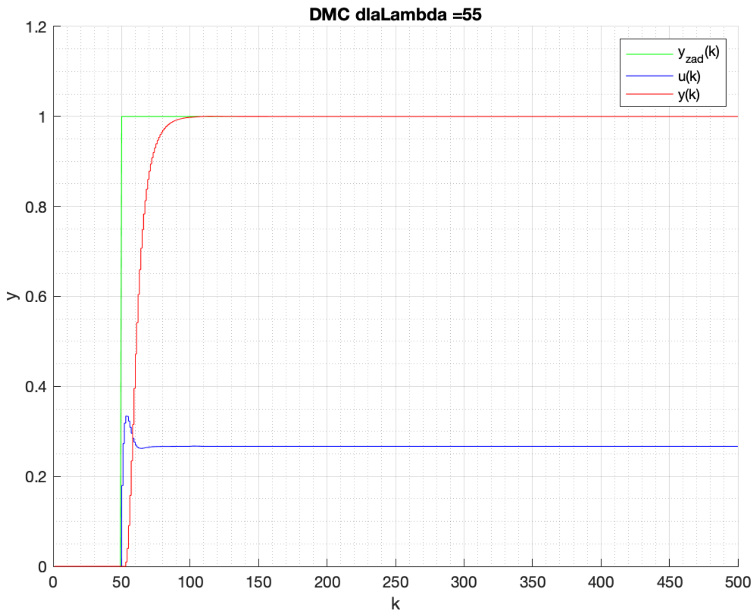

DMC dlaLambda =71
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
50
100
150
200
250
300
350
400
450
500


DMC dlaLambda =61
y
k
y_zad(k)
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

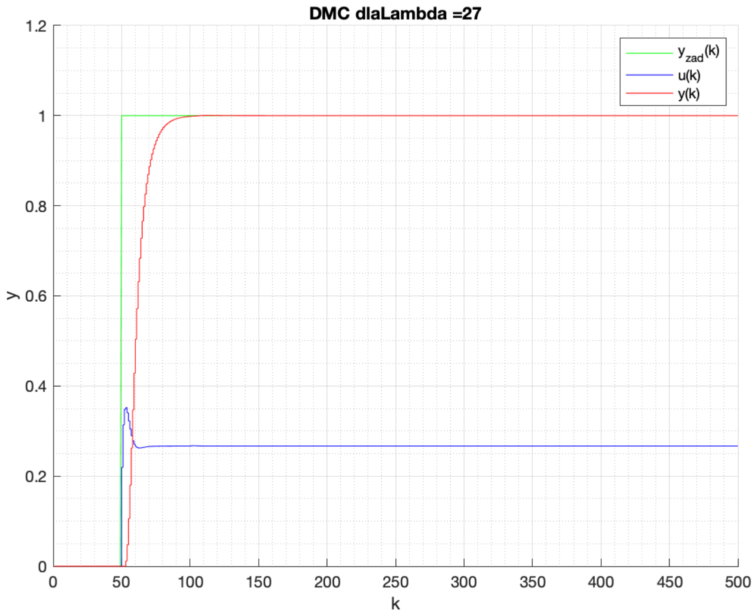

DMC dlaLambda =13
y
k
y_zad(k)
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

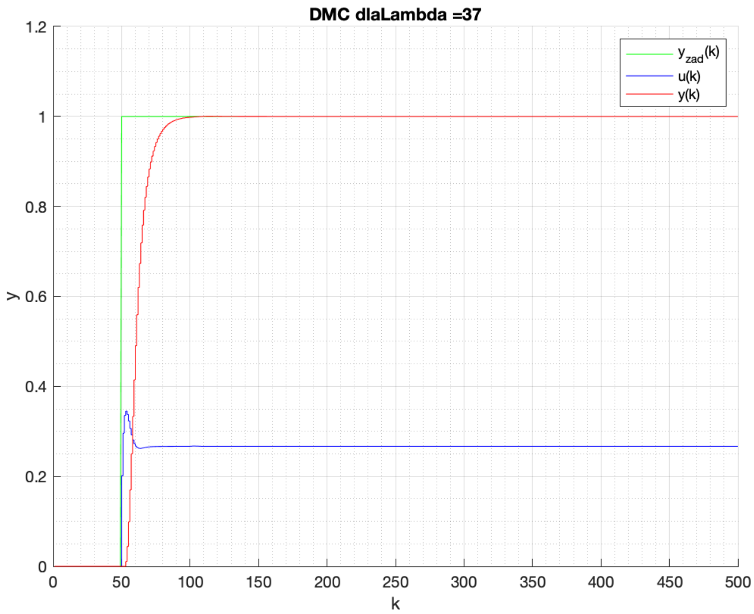


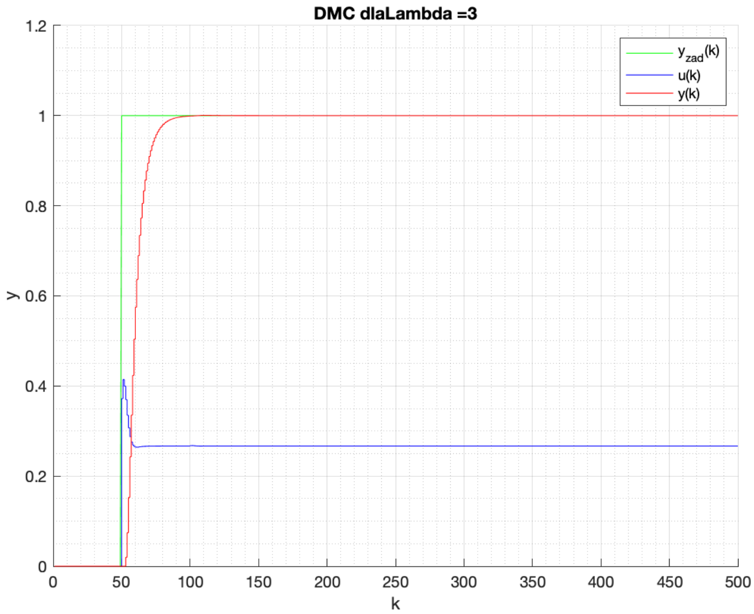
DMC dlaLambda =45
$y_{zad}(k)$
u(k)
y(k)
y
k

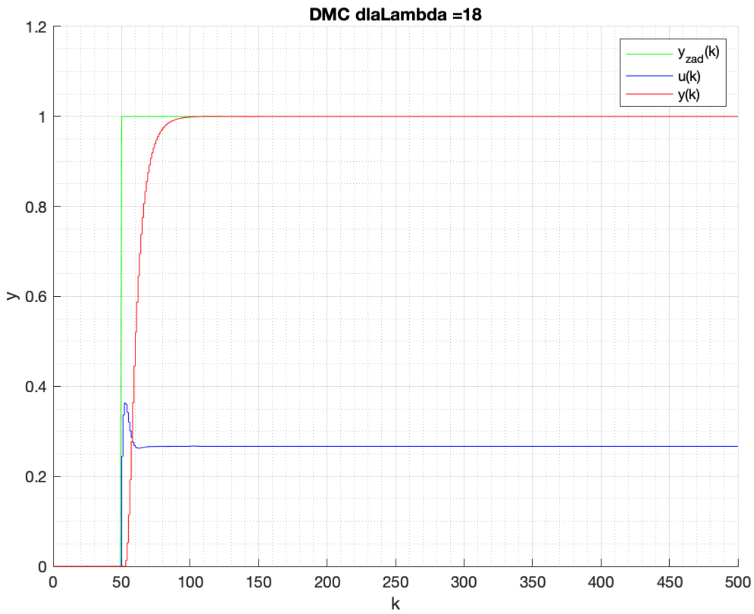


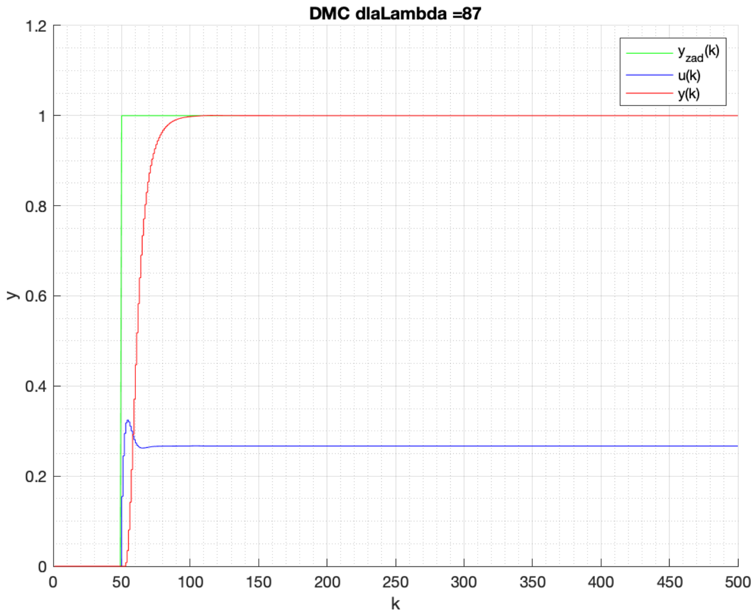
DMC dlaLambda =55
$y_{zad}(k)$
u(k)
y(k)
y
k

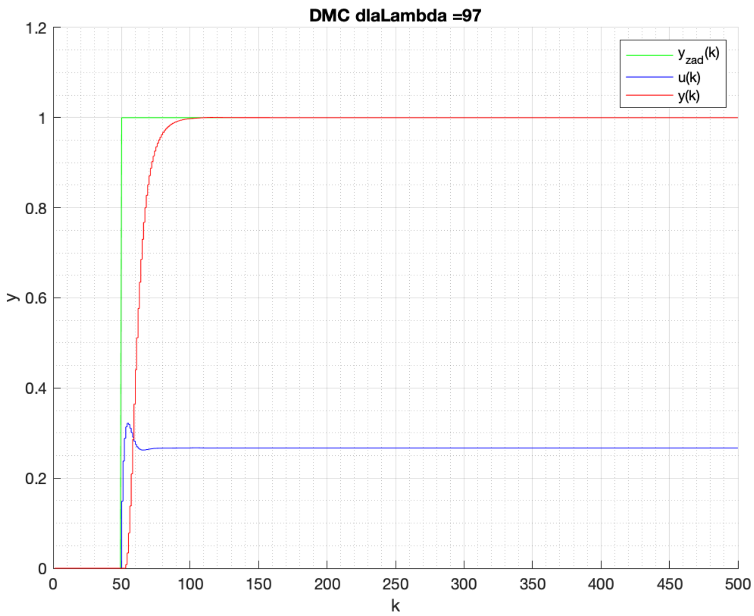

DMC dlaLambda =27
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

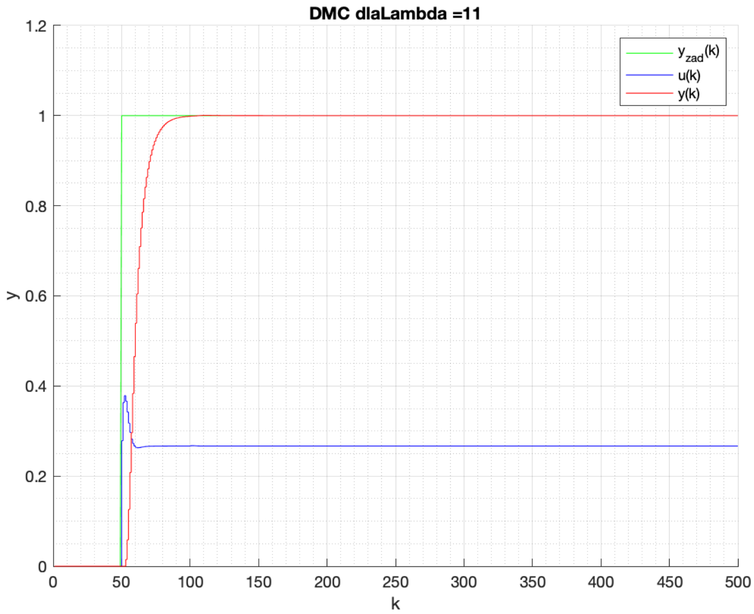

DMC dlaLambda =37
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

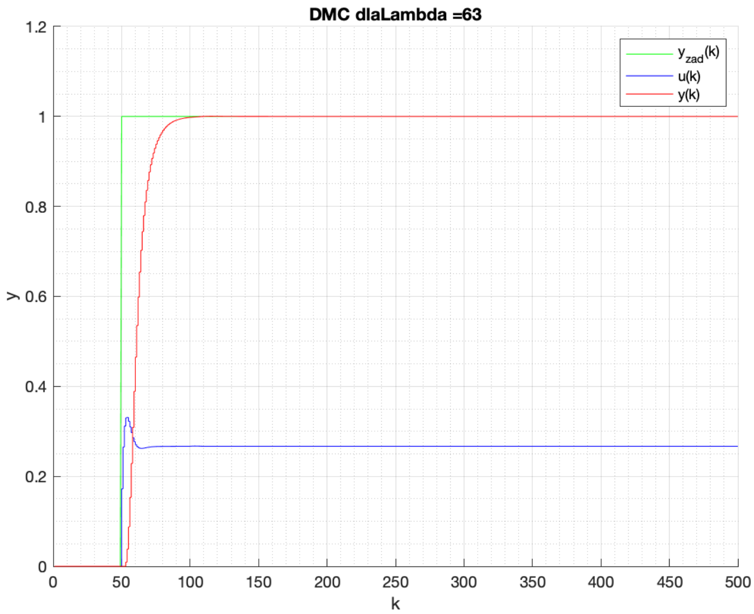

DMC dlaLambda =3
y
k
$y_{zad}(k)$
u(k)
y(k)

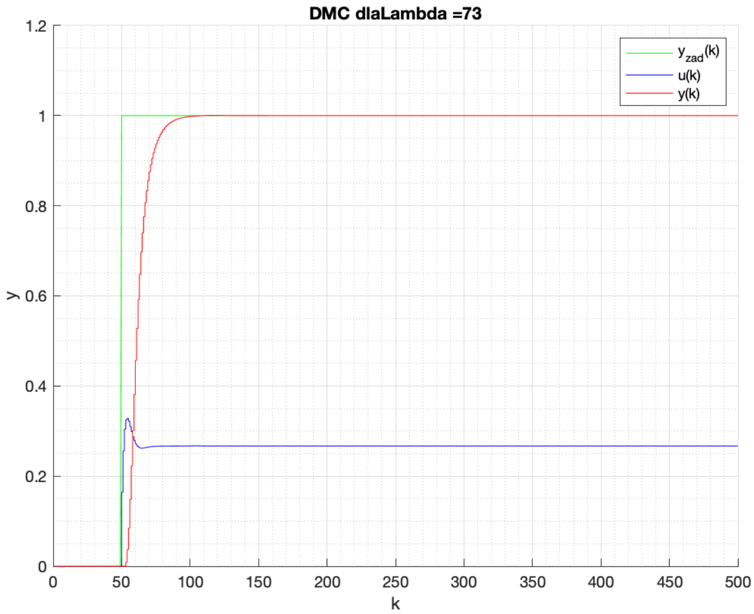

DMC dlaLambda =18
y
k
$y_{zad}(k)$
u(k)
y(k)

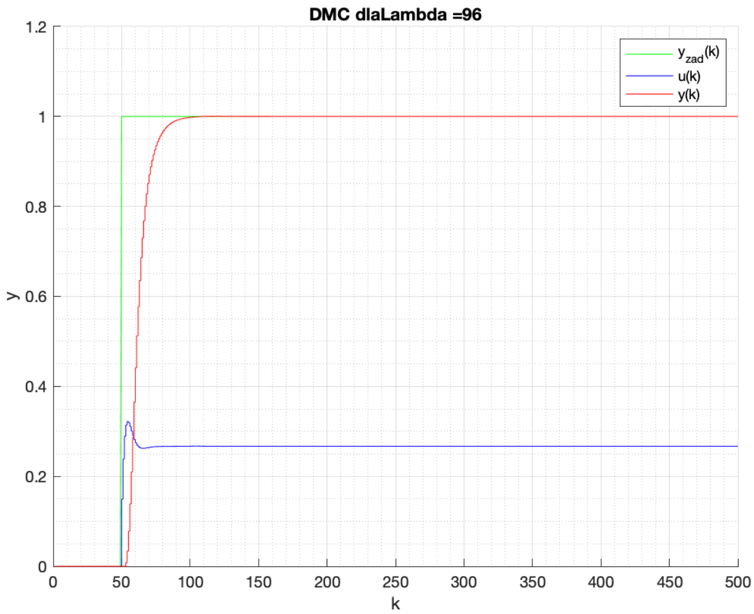

DMC dlaLambda =87
y
k
$y_{zad}(k)$
u(k)
y(k)

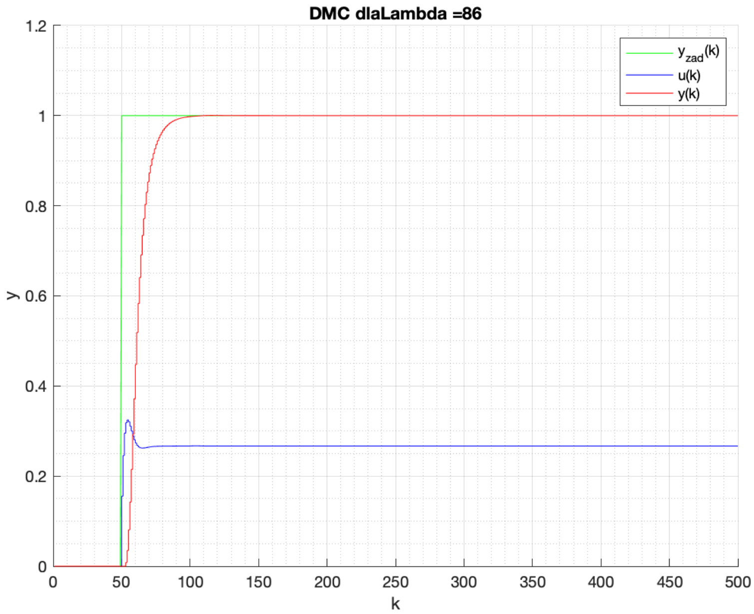

DMC dlaLambda =97
y
k
$y_{zad}(k)$
u(k)
y(k)


DMC dlaLambda =11
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

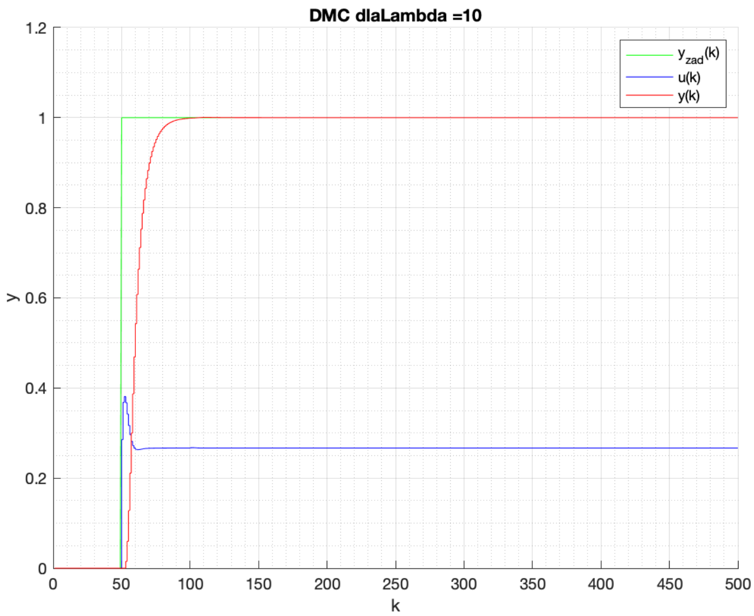

DMC dlaLambda =63
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500


DMC dlaLambda =73
y
k
$y_{zad}(k)$
u(k)
y(k)

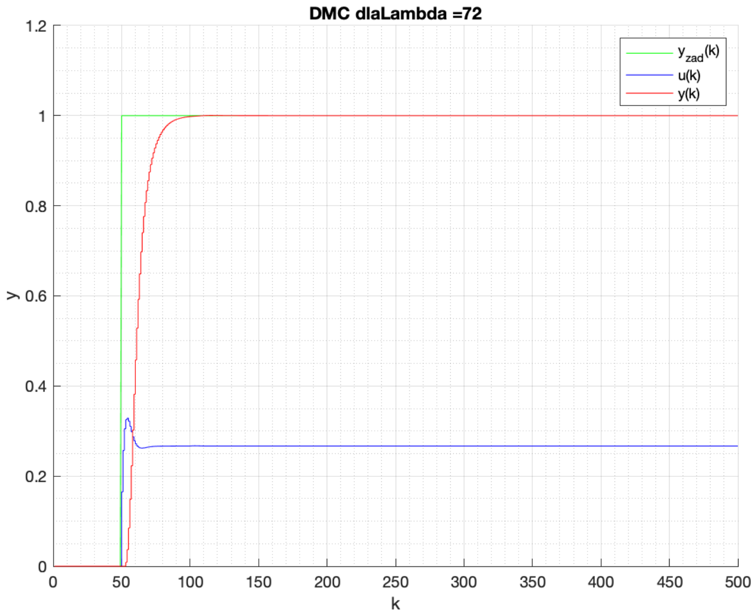

DMC dlaLambda =96
y
k
$y_{zad}(k)$
u(k)
y(k)

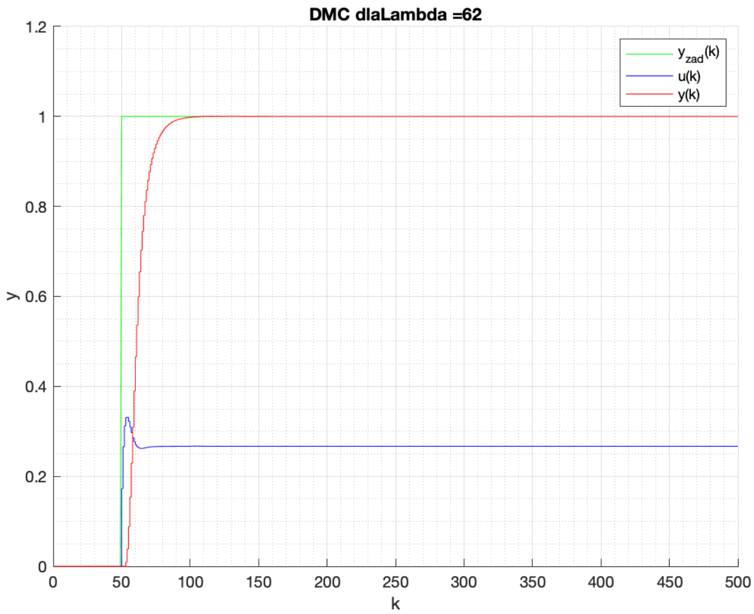


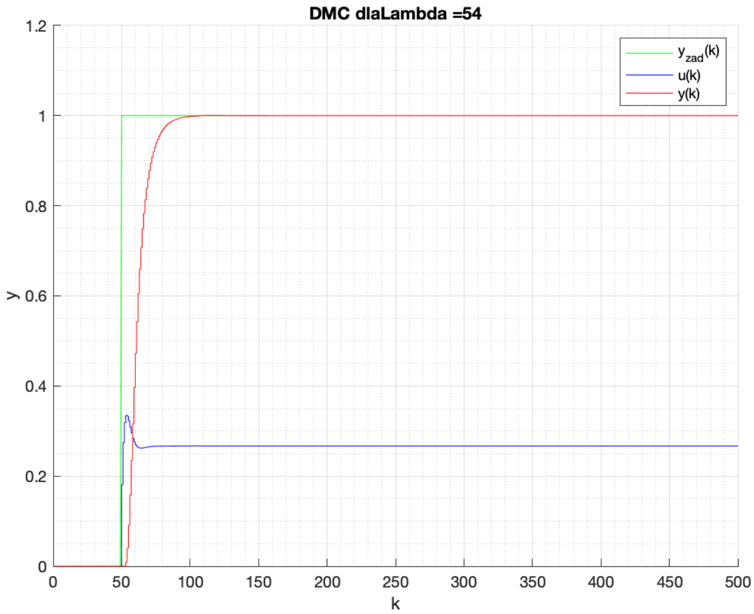
DMC dlaLambda =86
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

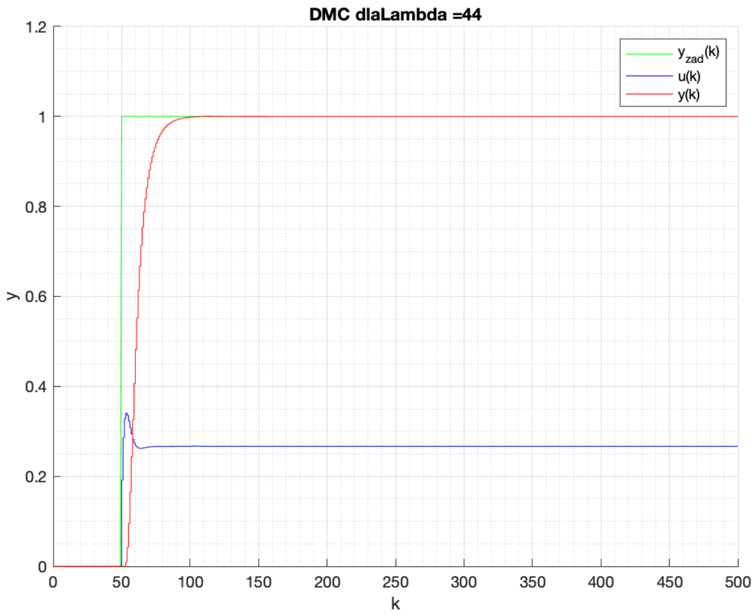


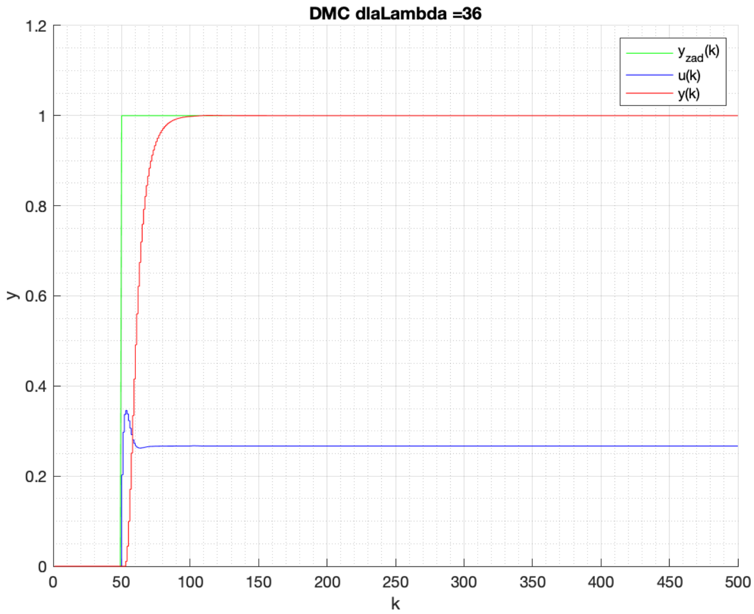
DMC dlaLambda =10
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

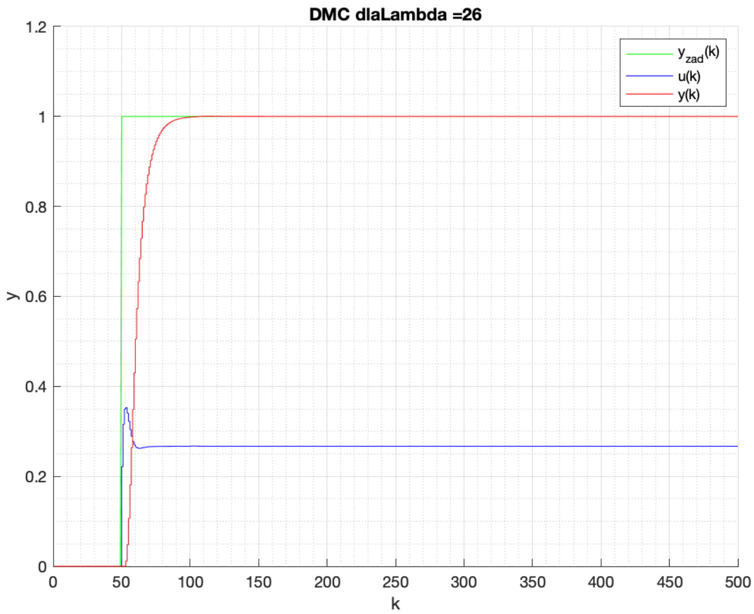

DMC dlaLambda =72
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500
yzad(k)
u(k)
y(k)

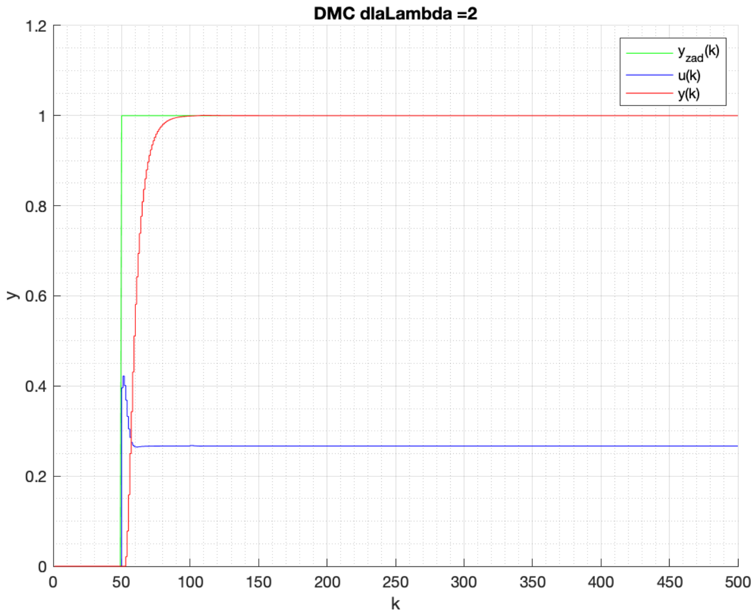

DMC dlaLambda =62
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500
yzad(k)
u(k)
y(k)


DMC dlaLambda =54
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

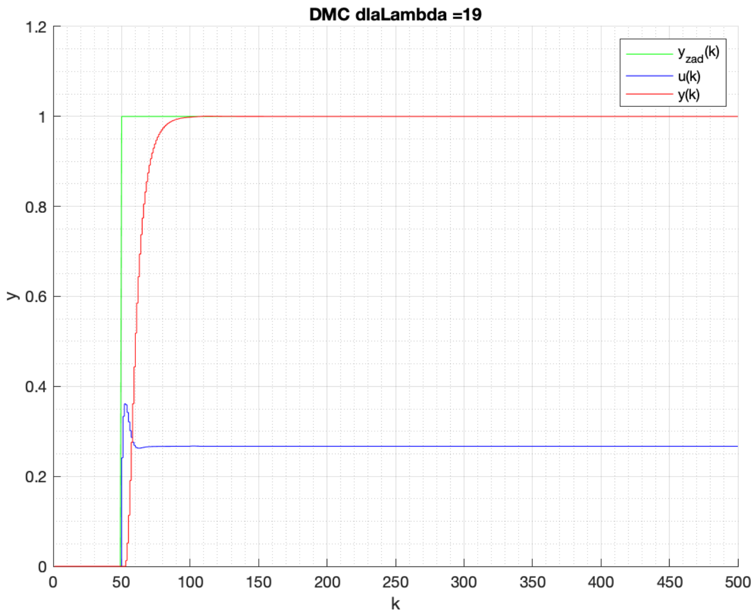

DMC dlaLambda =44
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500


DMC dlaLambda =36
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

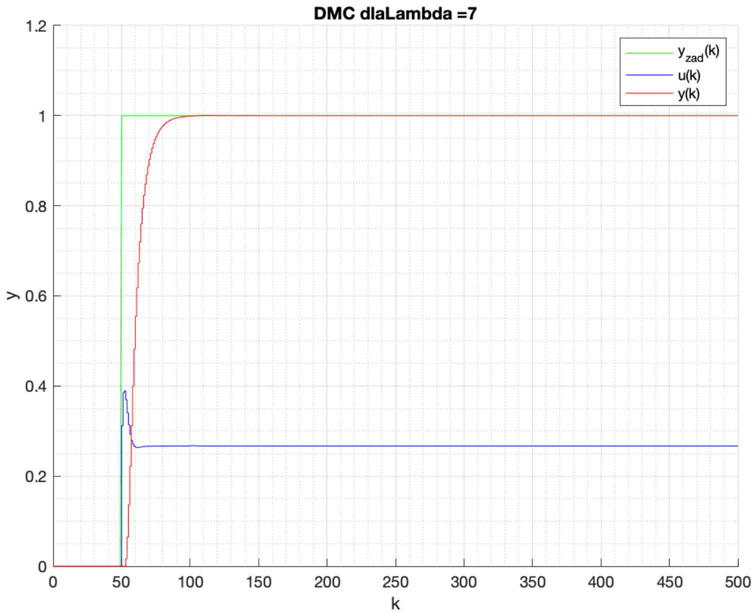

DMC dlaLambda =26
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500



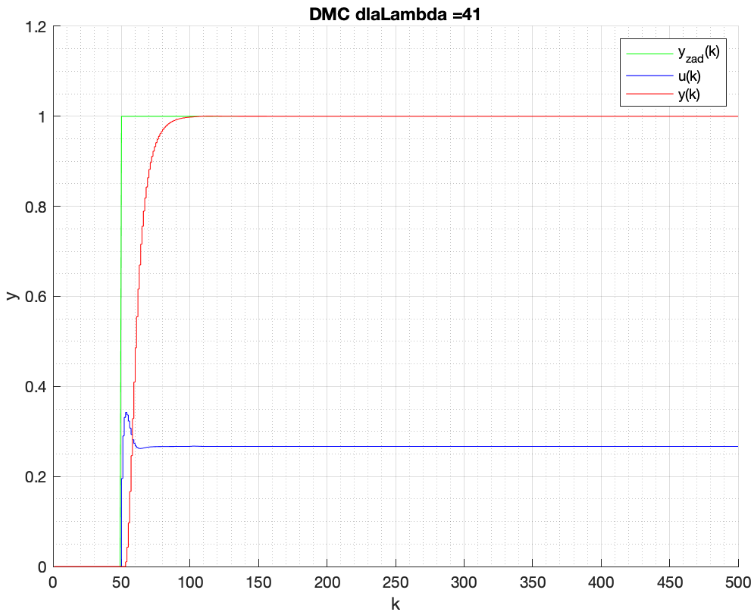
DMC dlaLambda =2
$y_{zad}(k)$
u(k)
y(k)
y
k



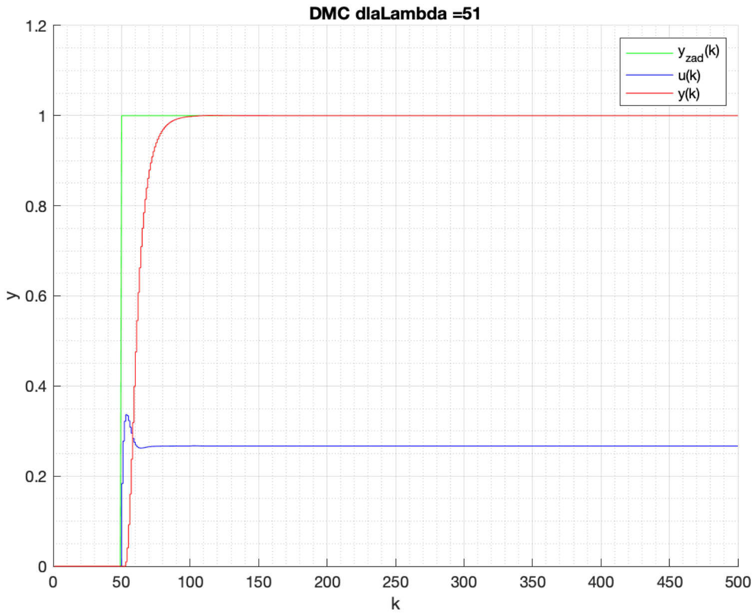
DMC dlaLambda =19
$y_{zad}(k)$
u(k)
y(k)
y
k

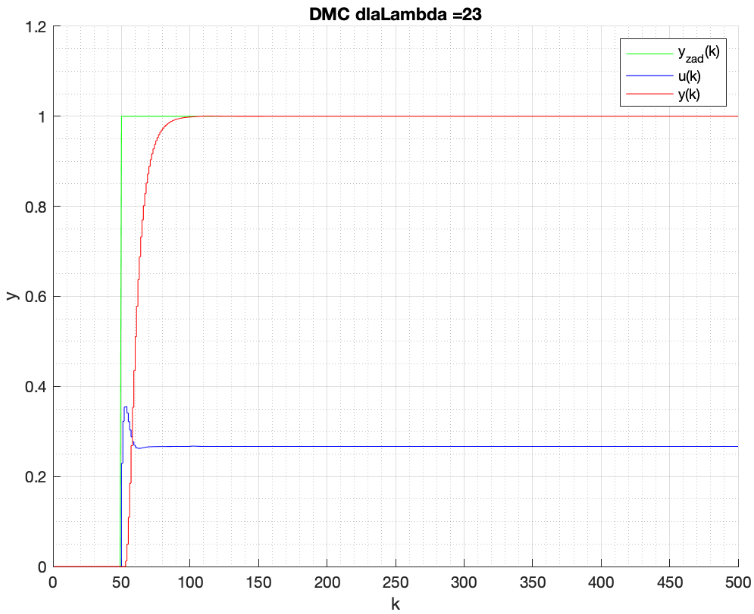


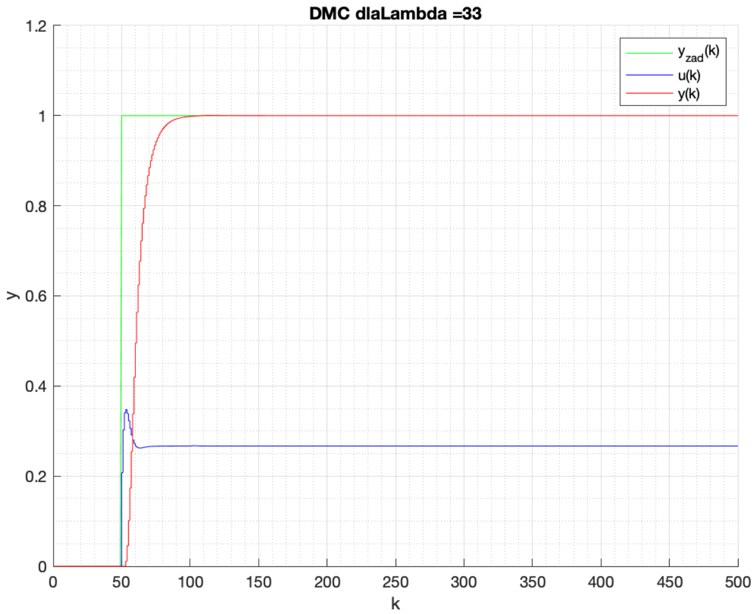
DMC dlaLambda =7
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0.2
0.4
0.6
0.8
1
1.2

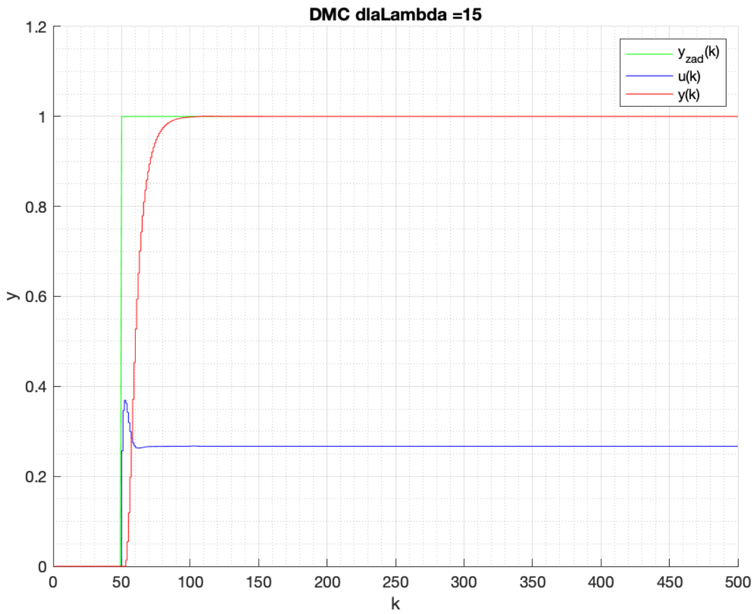


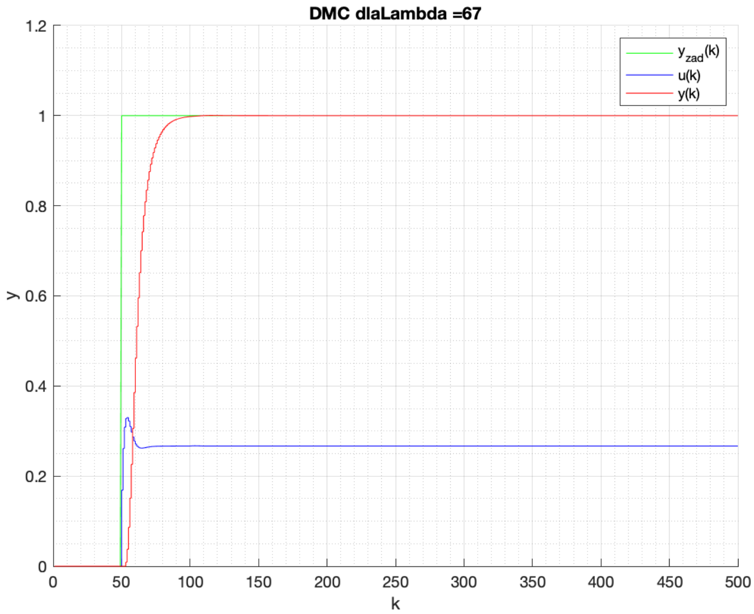
DMC dlaLambda =41
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0.2
0.4
0.6
0.8
1
1.2

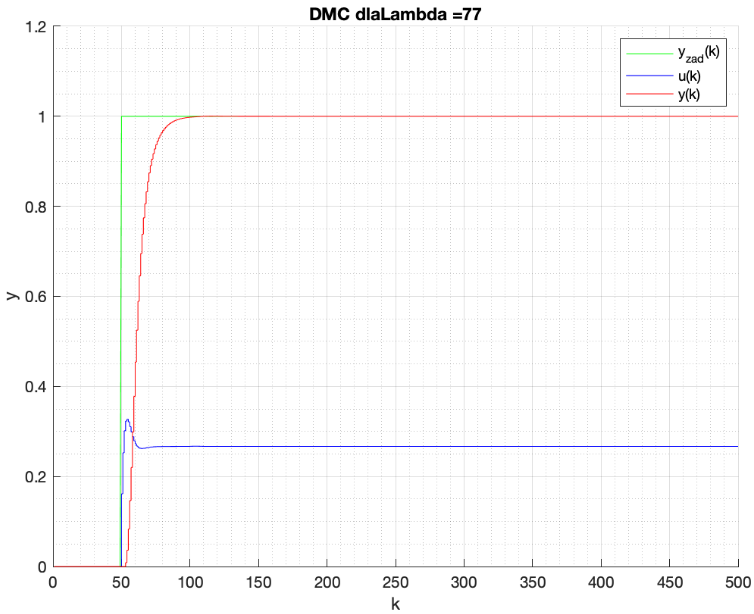

DMC dlaLambda =51
yzad(k)
u(k)
y(k)
y
k

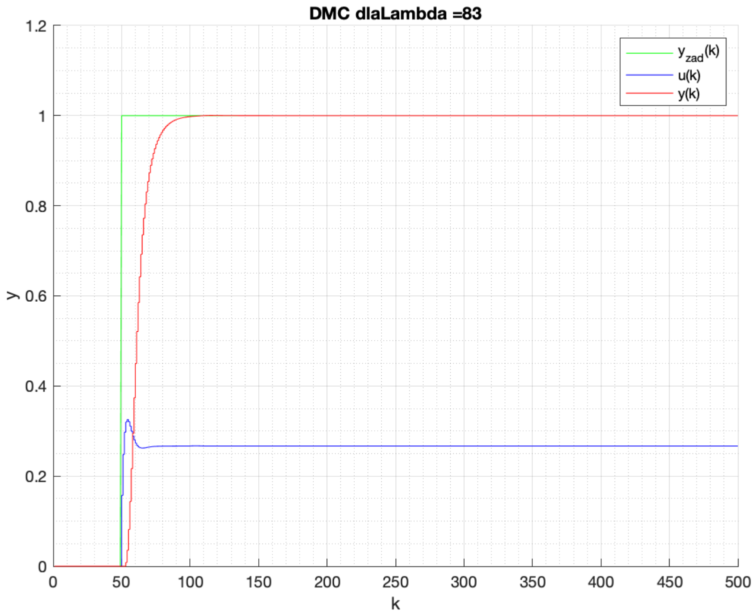

DMC dlaLambda =23
yzad(k)
u(k)
y(k)
y
k

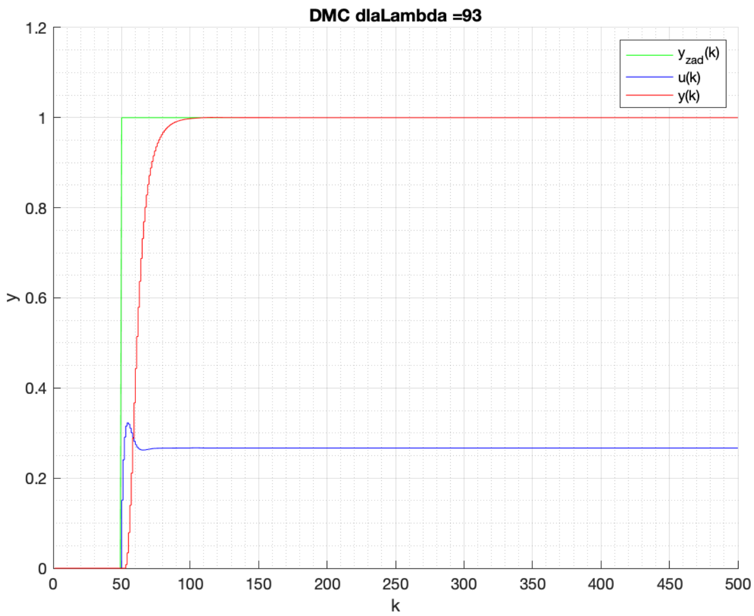

DMC dlaLambda =33
y
k
$y_{zad}(k)$
u(k)
y(k)

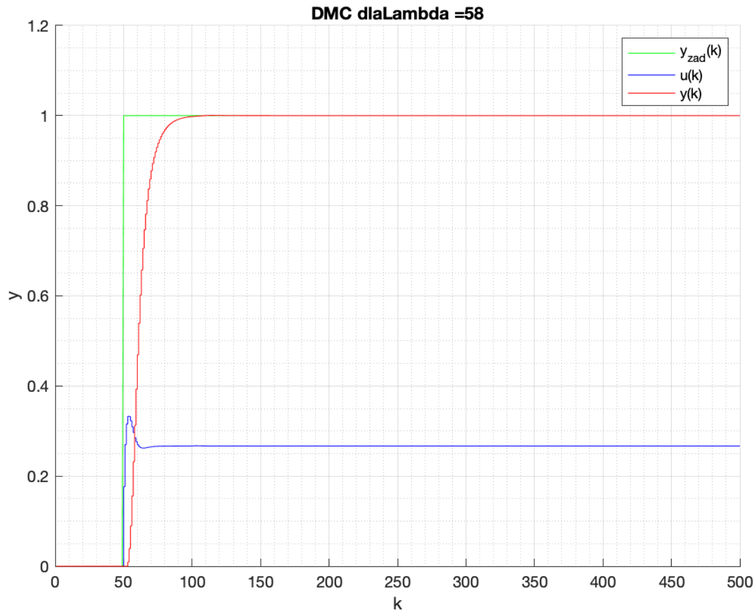

DMC dlaLambda =15
y
k
$y_{zad}(k)$
u(k)
y(k)

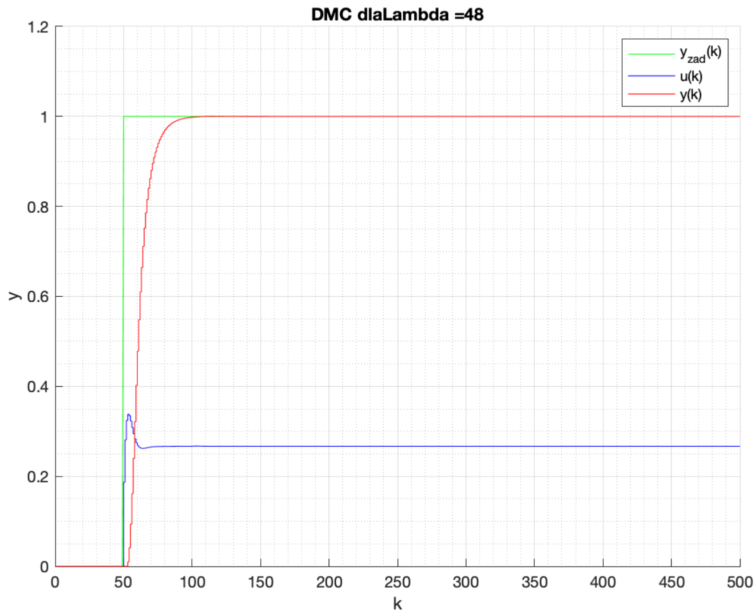

DMC dlaLambda =67
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

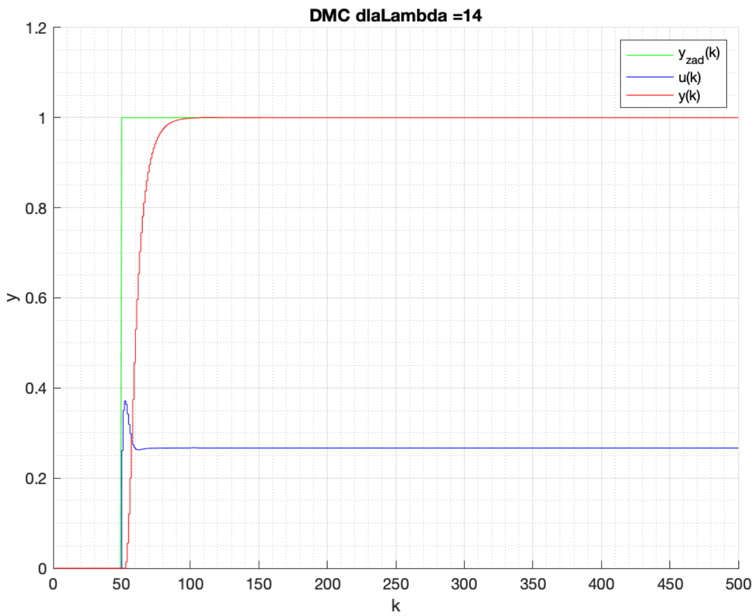

DMC dlaLambda =77
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

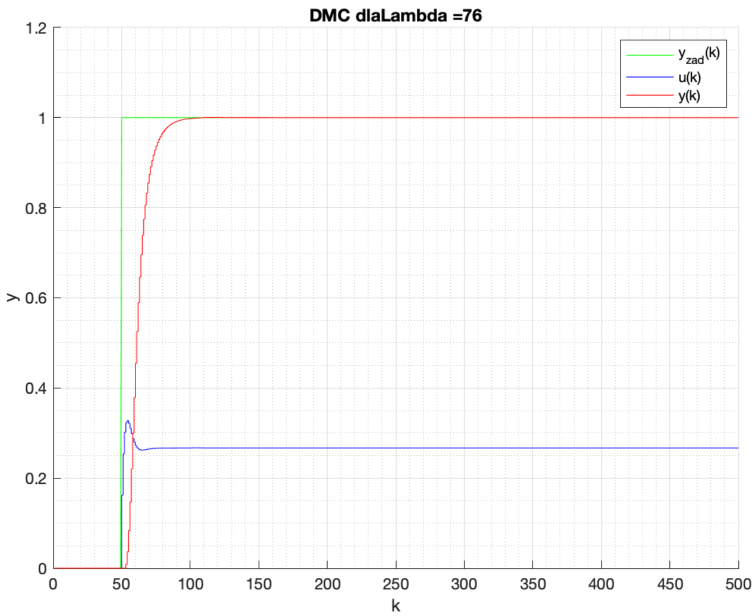

DMC dlaLambda =83
y
k
y_zad(k)
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

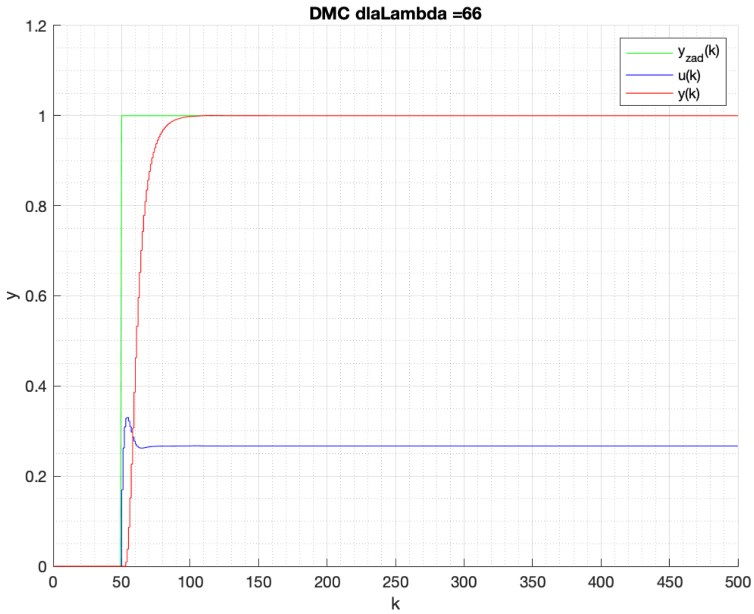

DMC dlaLambda =93
y
k
y_zad(k)
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

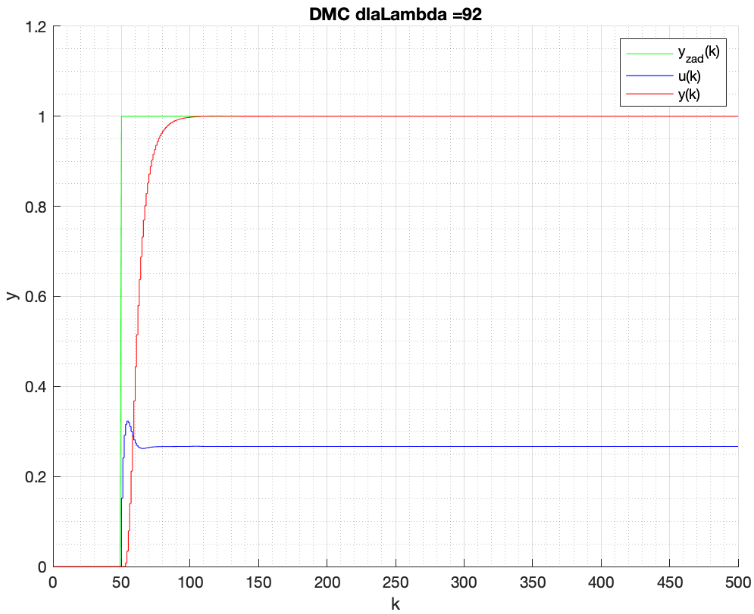

DMC dlaLambda =58
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

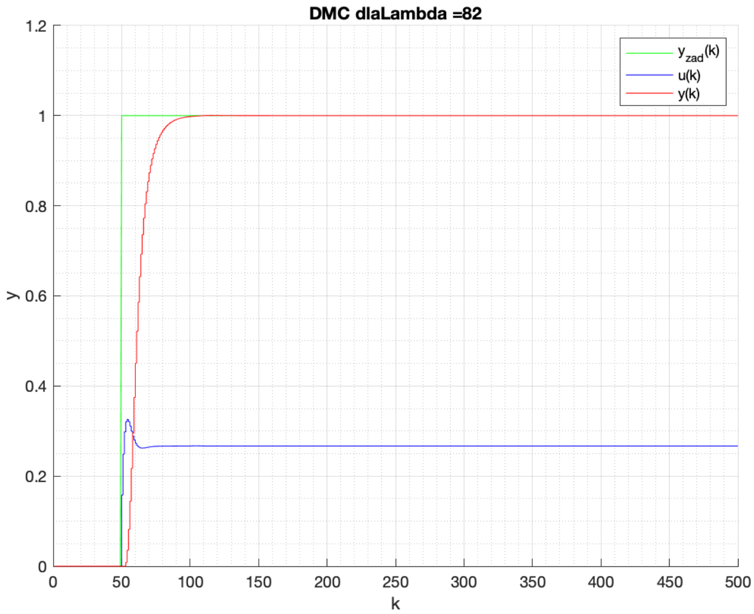

DMC dlaLambda =48
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

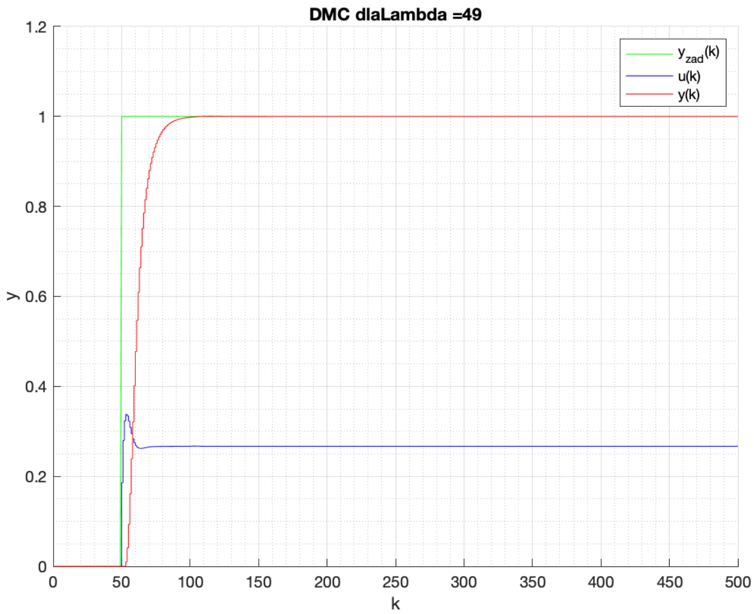

DMC dlaLambda =14
y
k
$y_{zad}(k)$
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

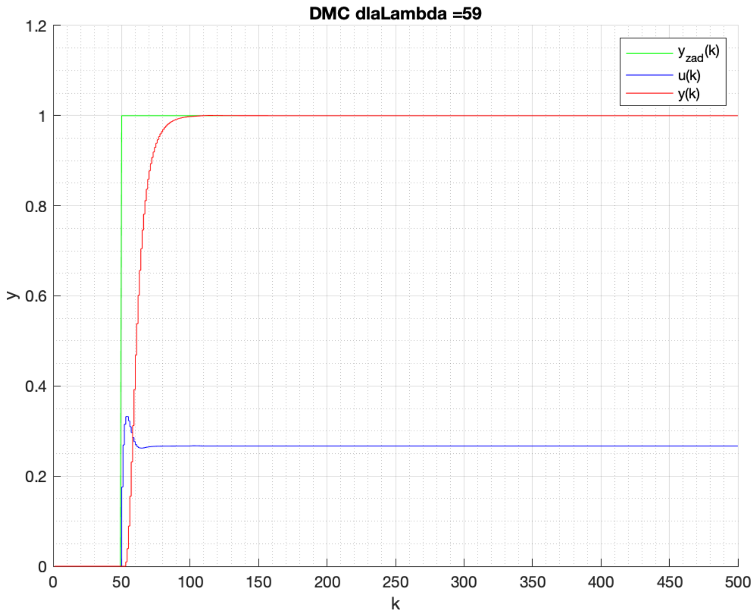

DMC dlaLambda =76
y
k
$y_{zad}(k)$
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

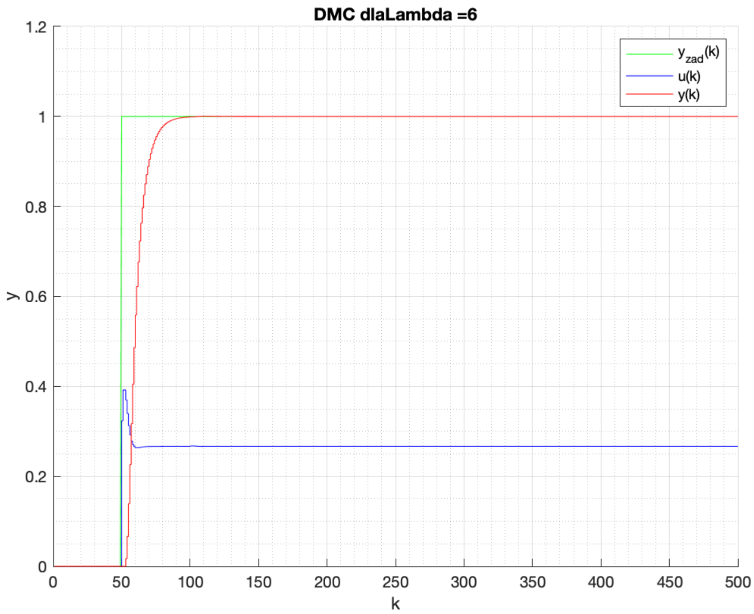

DMC dlaLambda =66
y
k
$y_{zad}(k)$
u(k)
y(k)

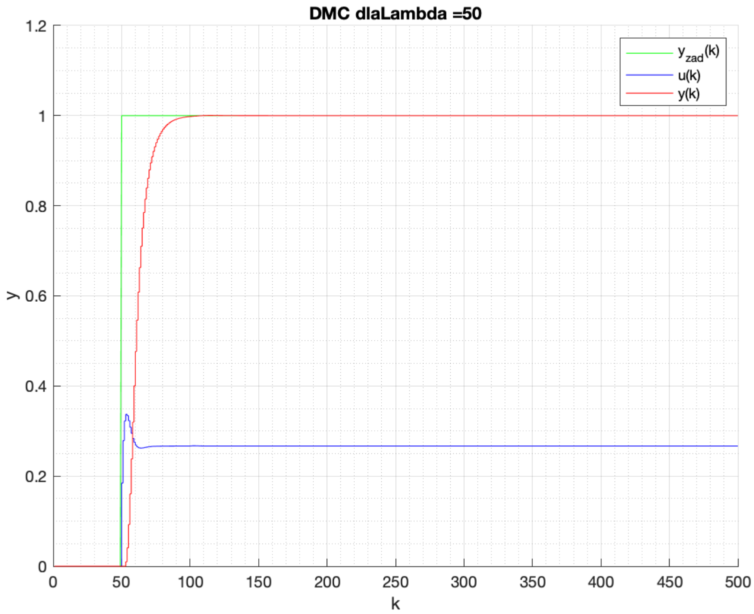

DMC dlaLambda =92
y
k
$y_{zad}(k)$
u(k)
y(k)

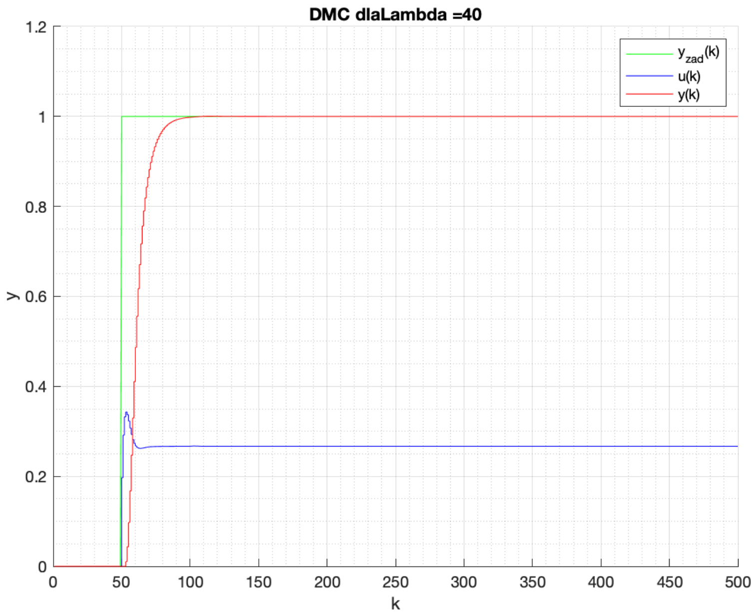

DMC dlaLambda =82
y_{zad}(k)
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

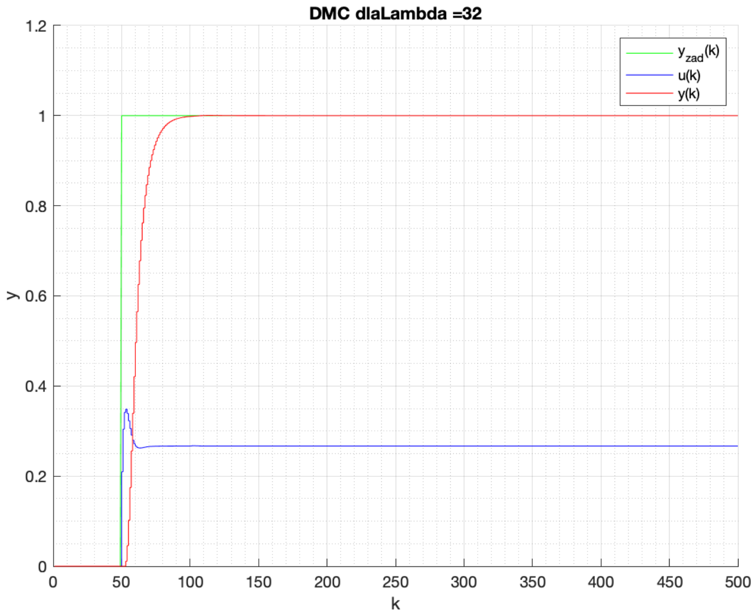

DMC dlaLambda =49
y_{zad}(k)
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

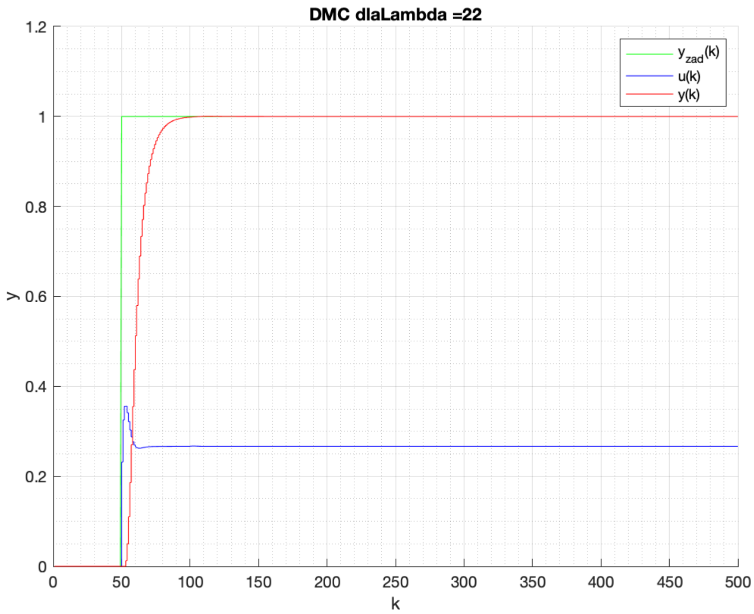

DMC dlaLambda =59
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

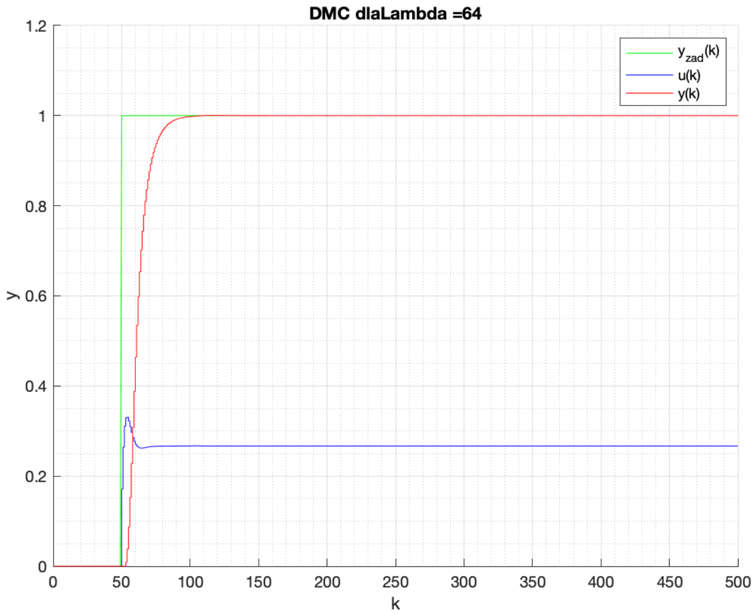

DMC dlaLambda =6
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500


DMC dlaLambda =50
y
k
y_zad(k)
u(k)
y(k)

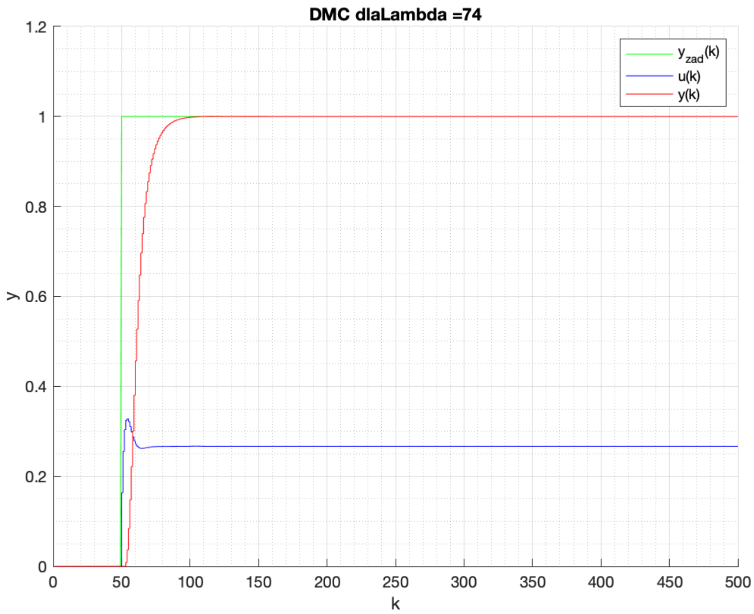

DMC dlaLambda =40
y
k
y_zad(k)
u(k)
y(k)


DMC dlaLambda =32
$y_{zad}(k)$
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

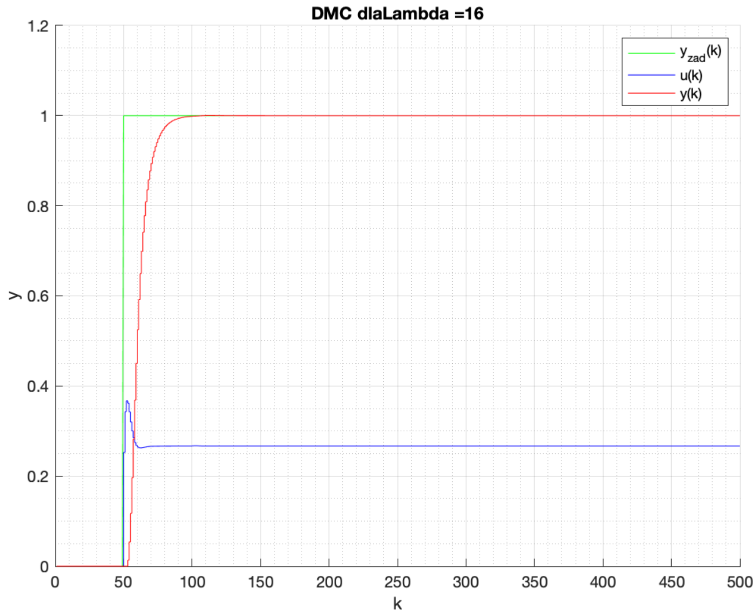

DMC dlaLambda =22
$y_{zad}(k)$
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

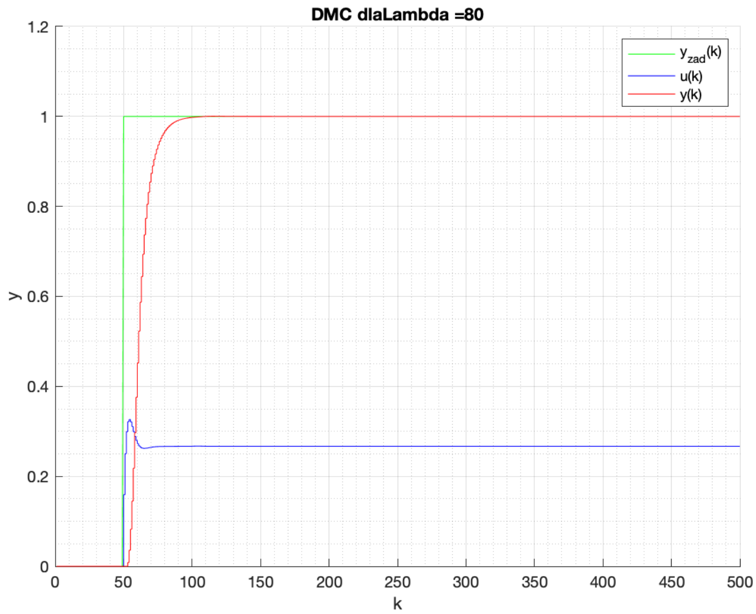


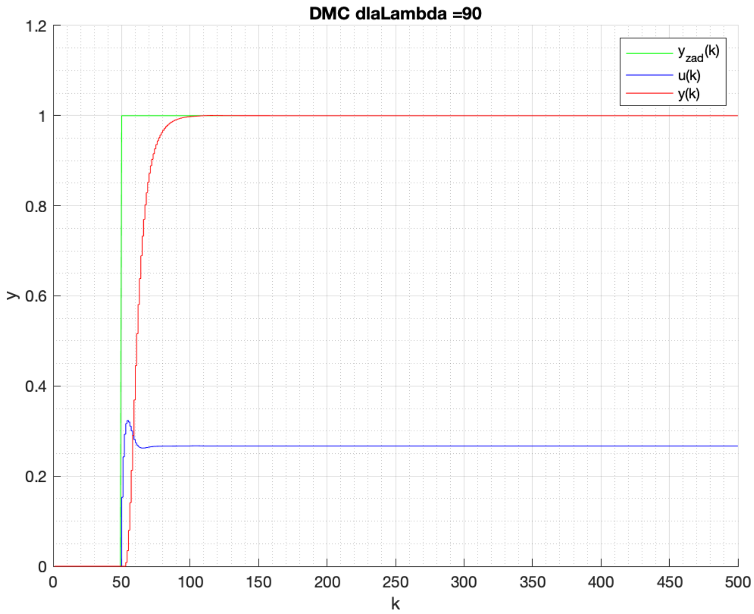
DMC dlaLambda =64
$y_{zad}(k)$
u(k)
y(k)
y
k

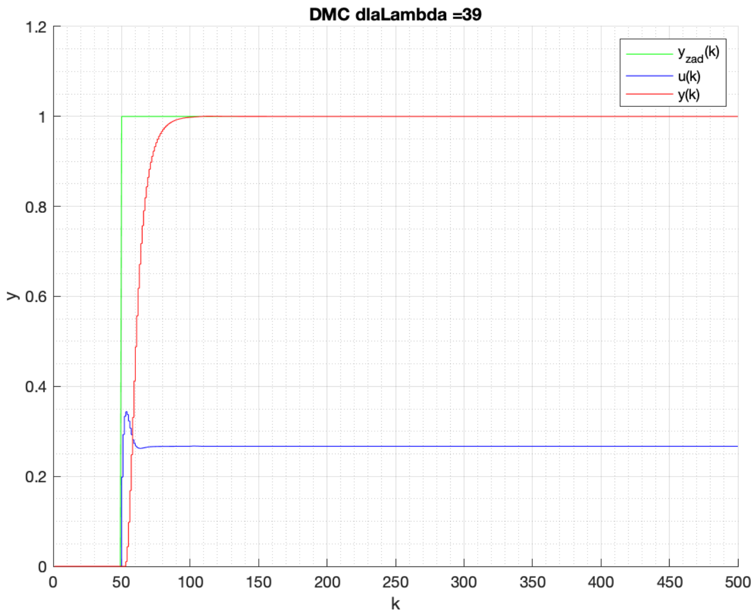


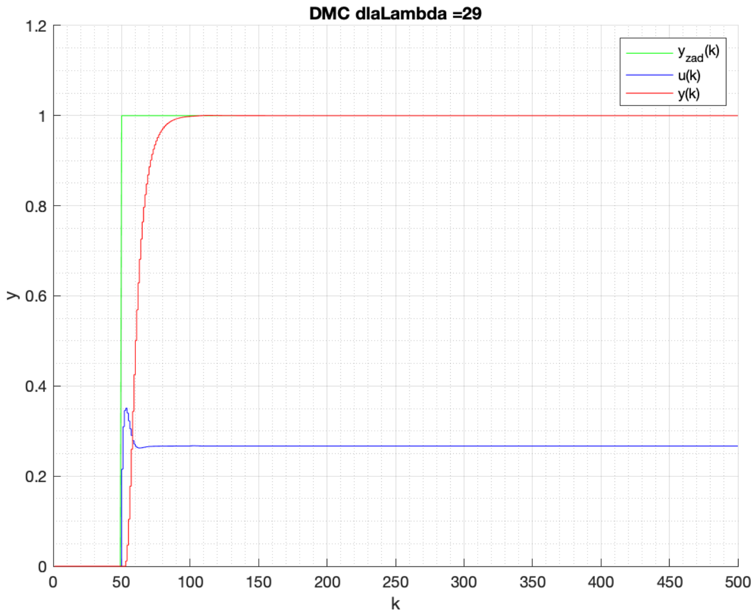
DMC dlaLambda =74
$y_{zad}(k)$
u(k)
y(k)
y
k

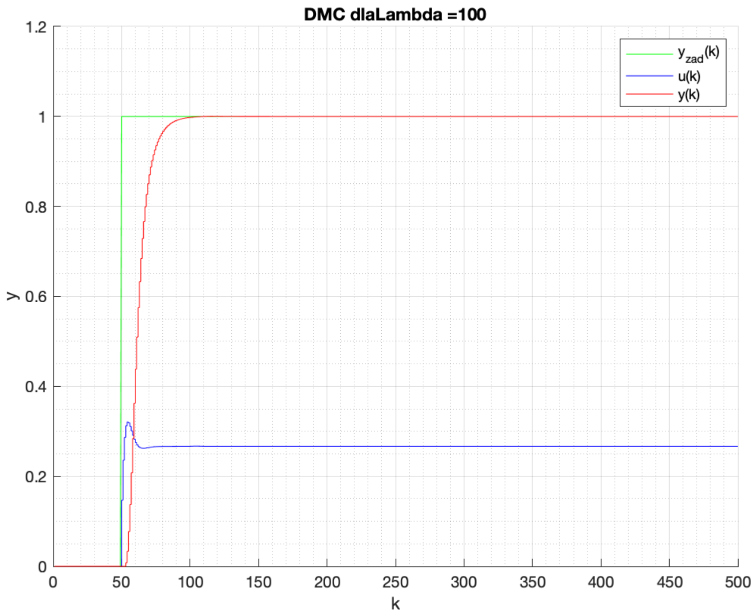

DMC dlaLambda =16
$y_{zad}(k)$
u(k)
y(k)
y
k

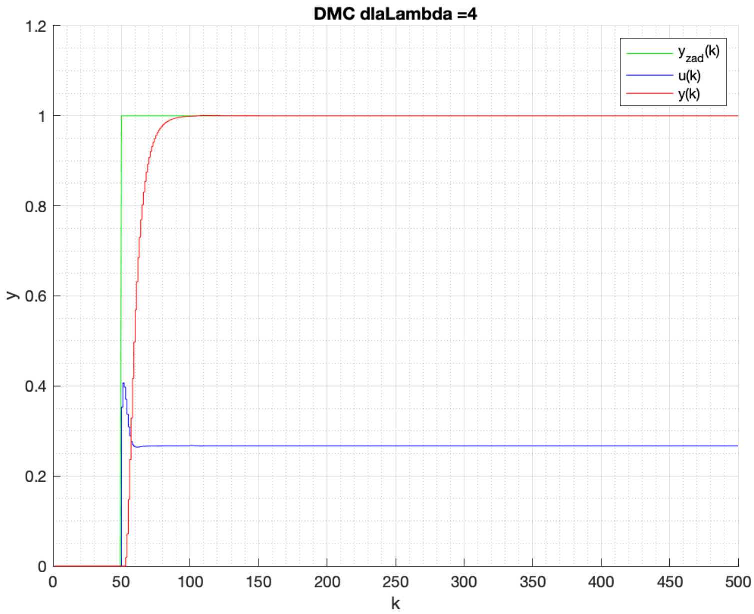

DMC dlaLambda =80
$y_{zad}(k)$
u(k)
y(k)
y
k

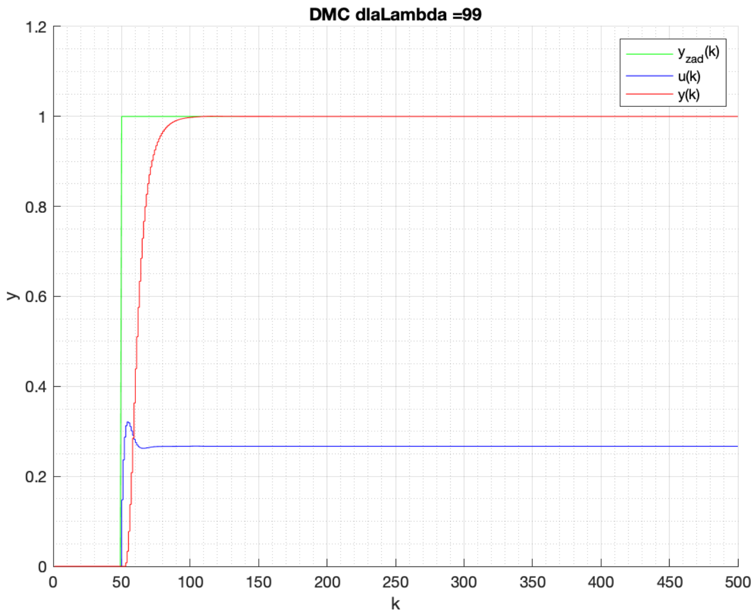

DMC dlaLambda =90
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

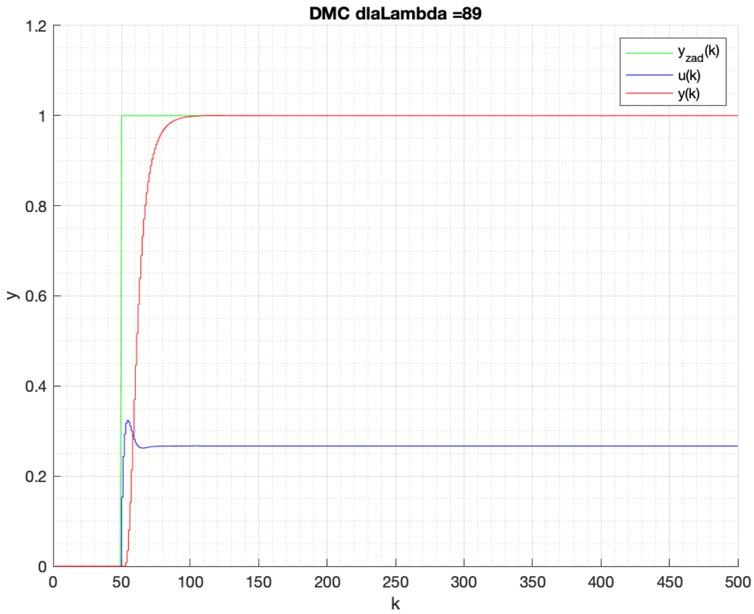

DMC dlaLambda =39
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

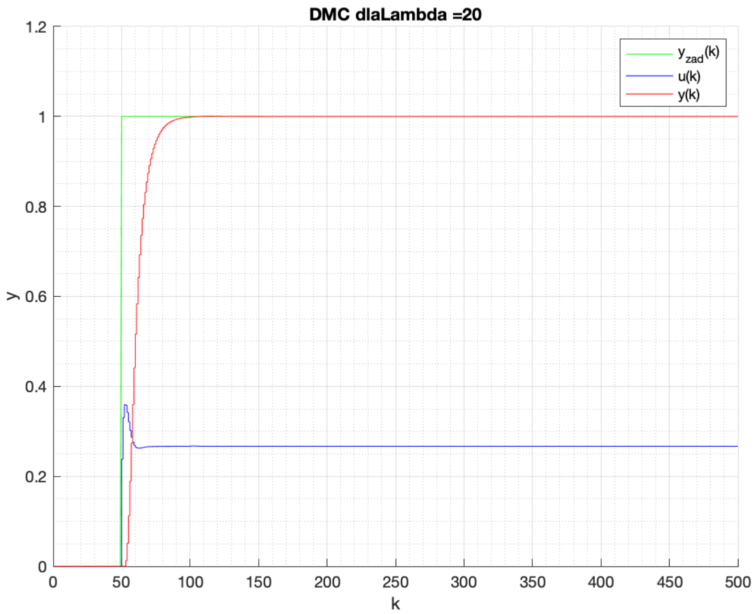

DMC dlaLambda =29
$y_{zad}(k)$
u(k)
y(k)
y
k

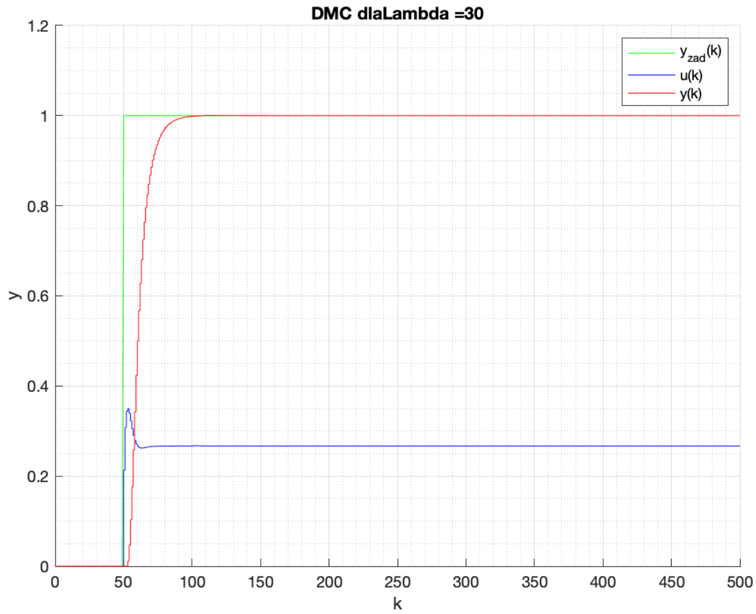

DMC dlaLambda =100
$y_{zad}(k)$
u(k)
y(k)
y
k

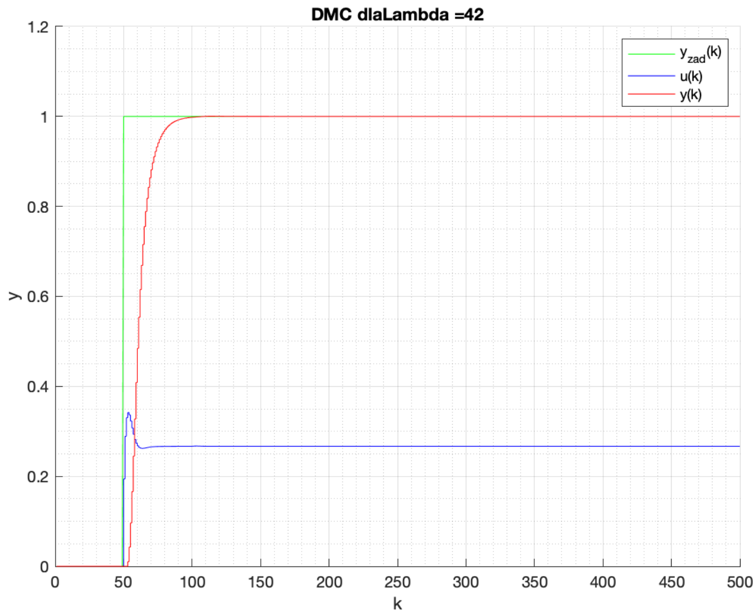

DMC dlaLambda =4
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
50
100
150
200
250
300
350
400
450
500

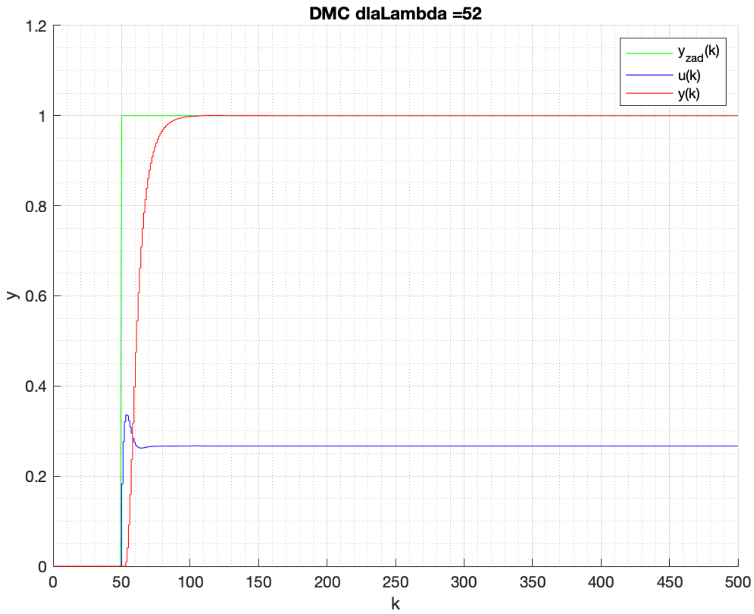

DMC dlaLambda =99
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
50
100
150
200
250
300
350
400
450
500

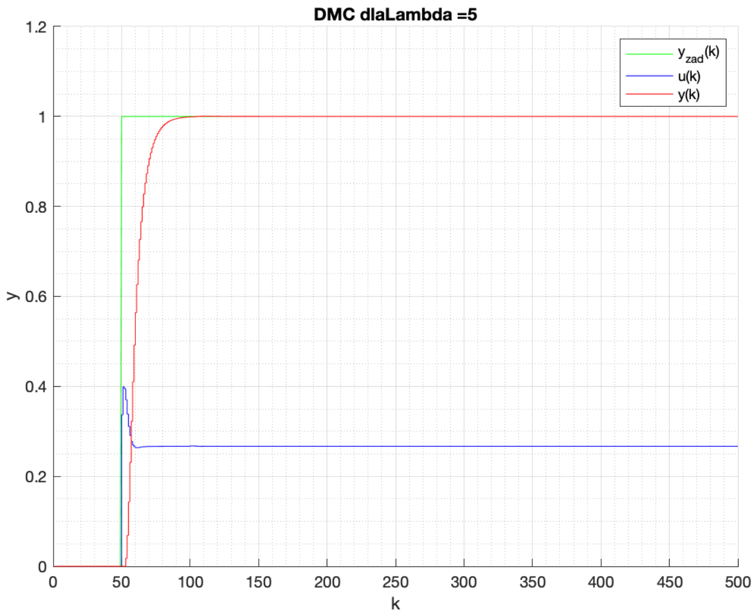

DMC dlaLambda =89
y
k
y_zad(k)
u(k)
y(k)

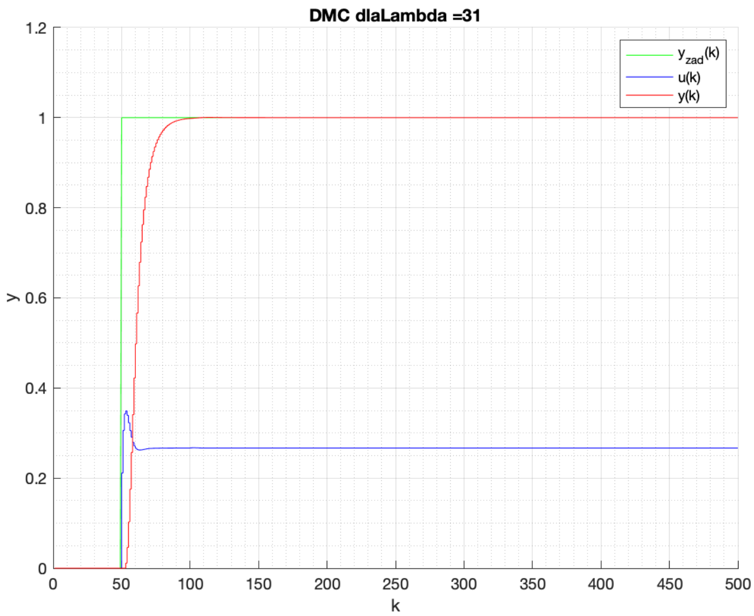

DMC dlaLambda =20
y
k
y_zad(k)
u(k)
y(k)

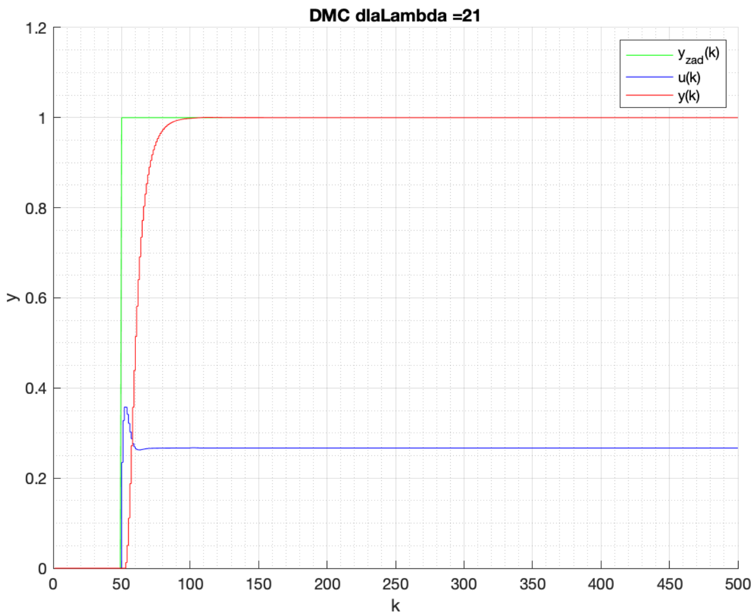

DMC dlaLambda =30
$y_{zad}(k)$
u(k)
y(k)
y
k

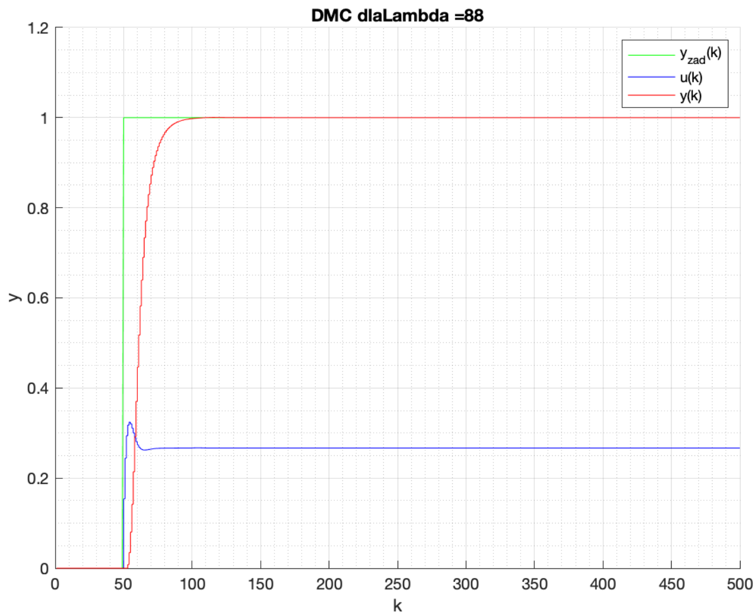

DMC dlaLambda =42
$y_{zad}(k)$
u(k)
y(k)
y
k

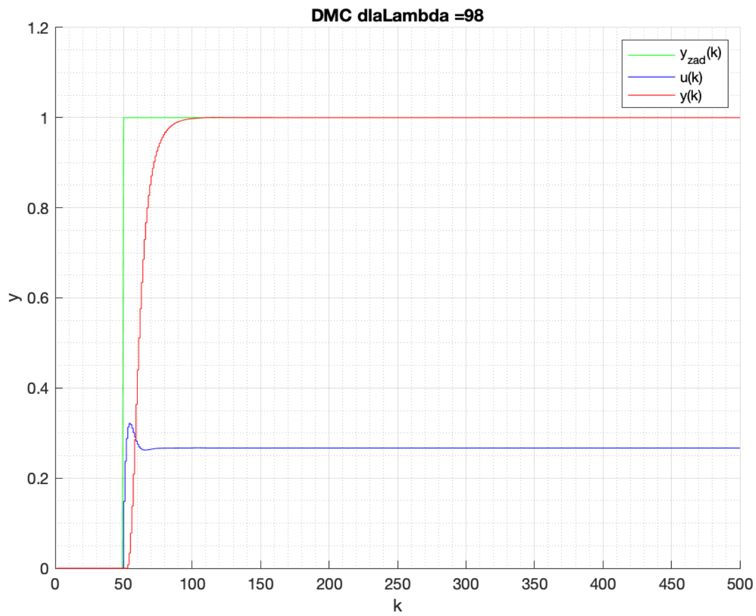

DMC dlaLambda =52
y_{zad}(k)
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

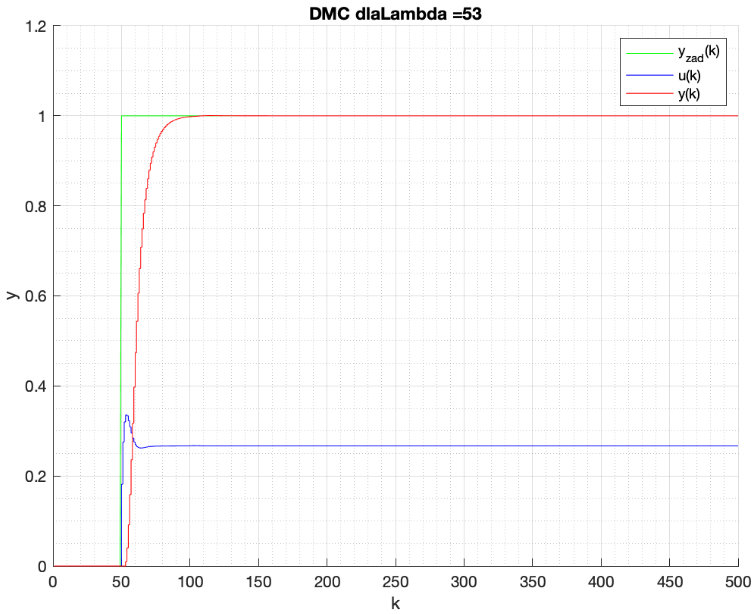

DMC dlaLambda =5
y_{zad}(k)
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

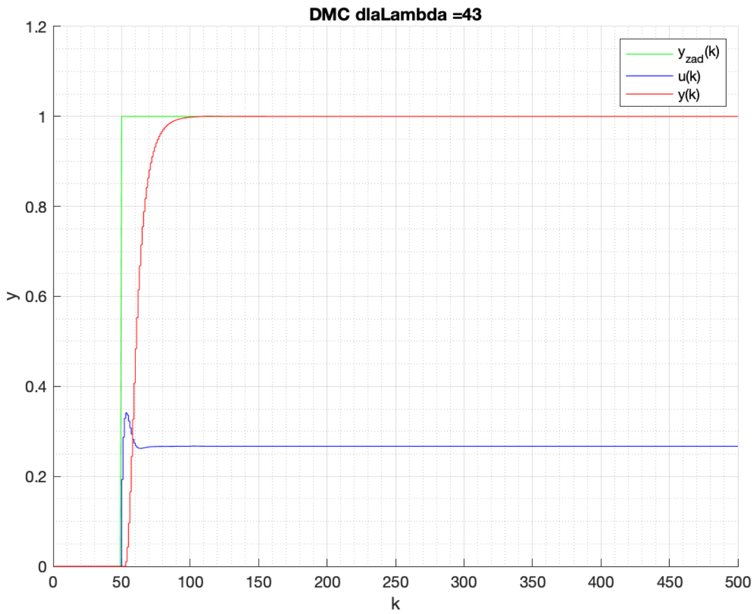

DMC dlaLambda =31
y
k
$y_{zad}(k)$
u(k)
y(k)

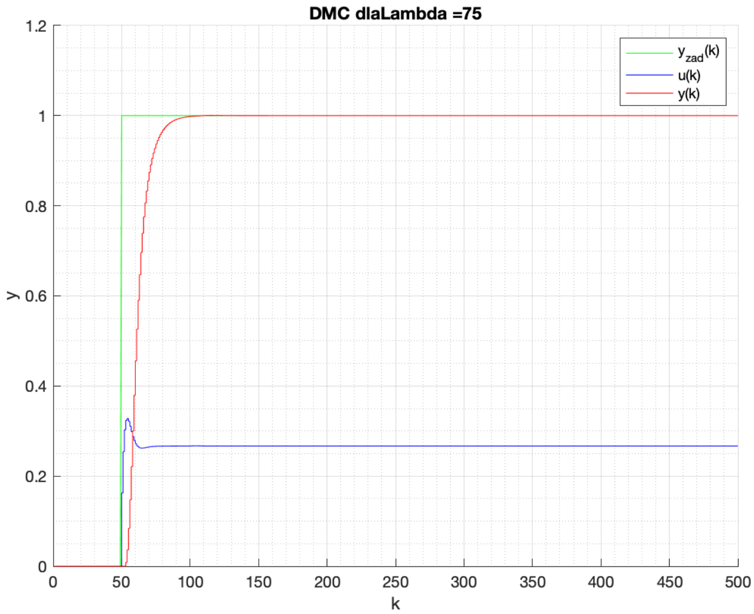

DMC dlaLambda =21
y
k
$y_{zad}(k)$
u(k)
y(k)

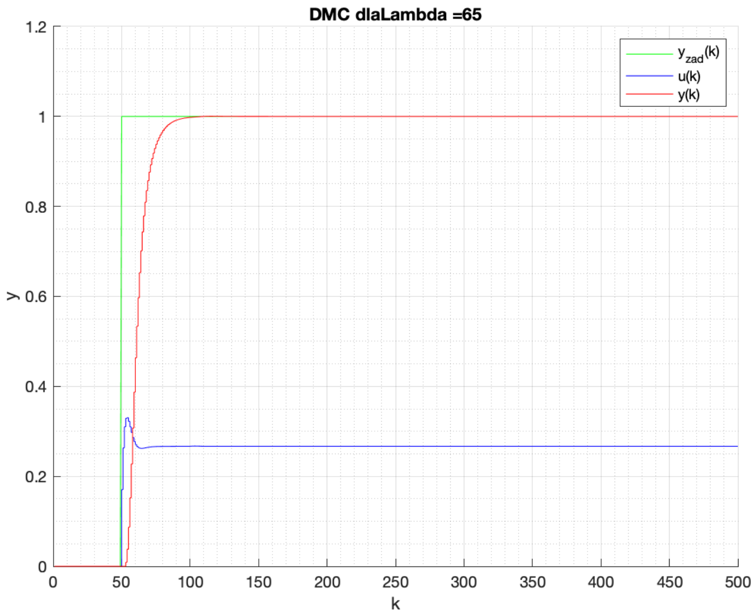

DMC dlaLambda =88
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

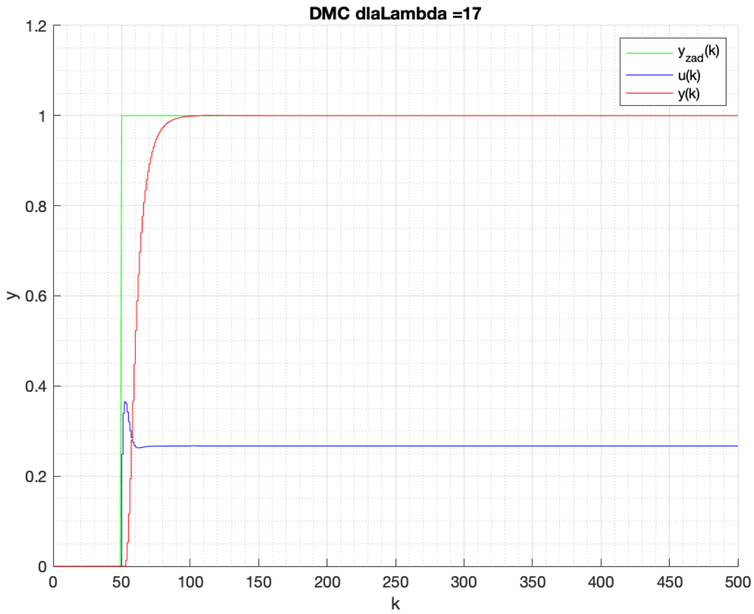

DMC dlaLambda =98
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

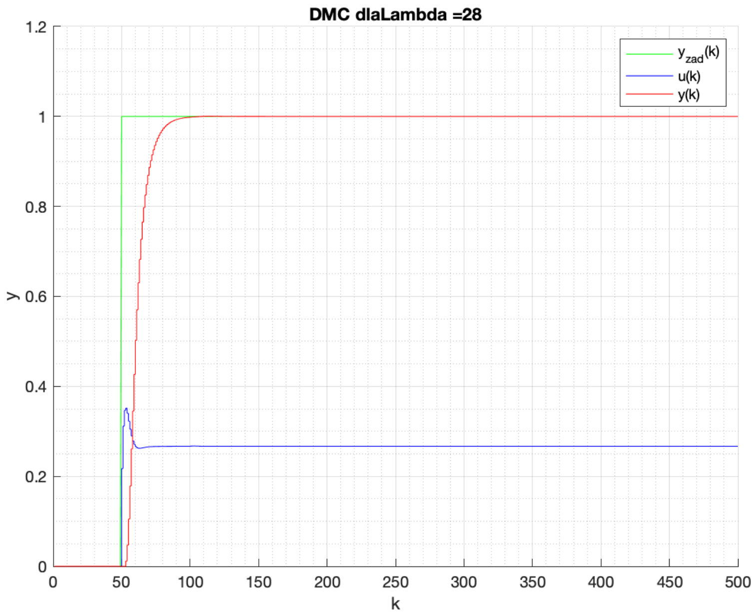

DMC dlaLambda =53
y
k
yzad(k)
u(k)
y(k)

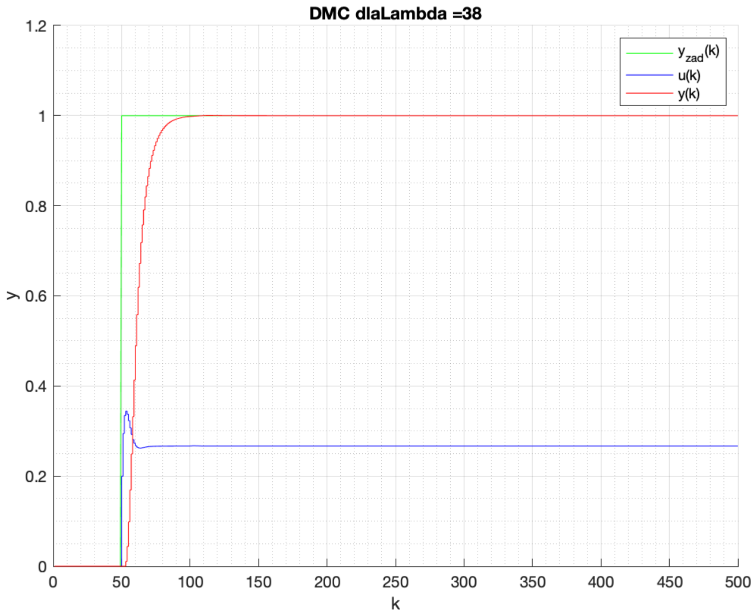

DMC dlaLambda =43
y
k
yzad(k)
u(k)
y(k)

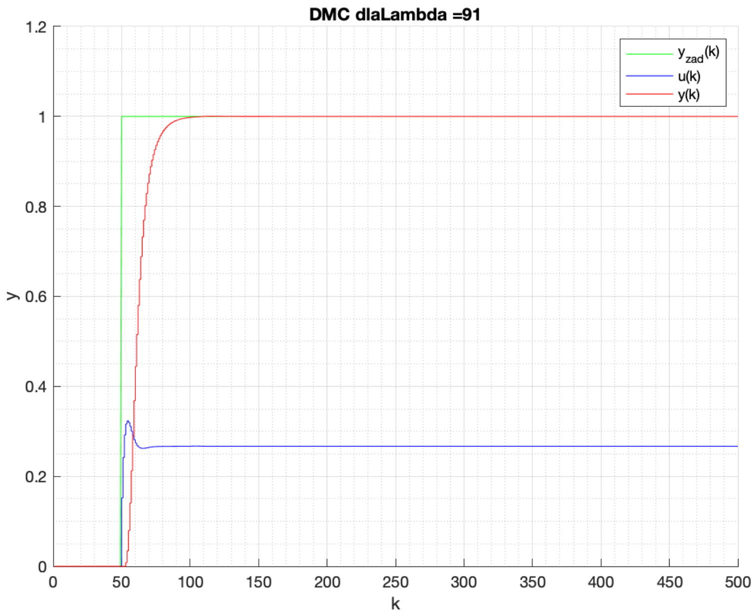

DMC dlaLambda =75
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

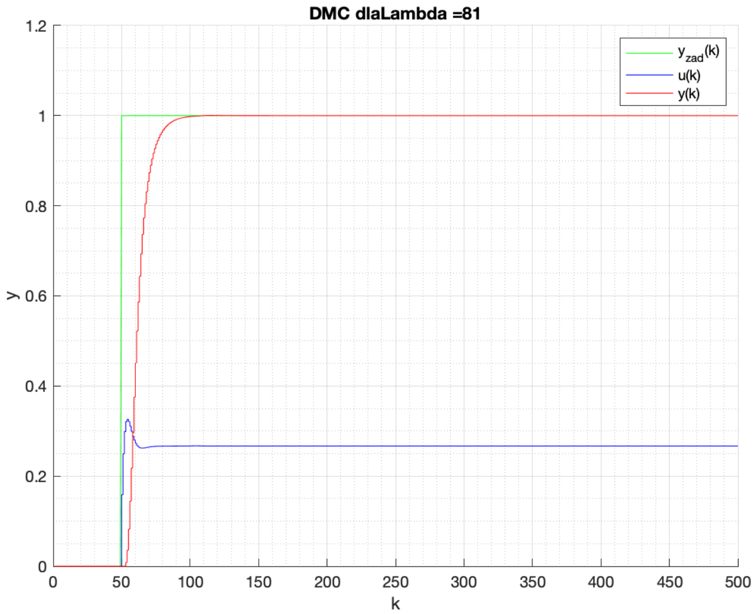

DMC dlaLambda =65
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

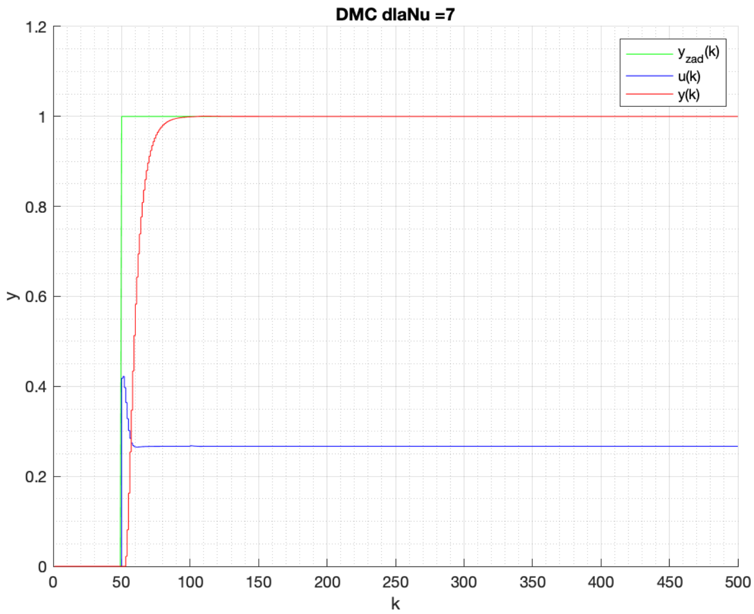

DMC dlaLambda =17
y
k
$y_{zad}(k)$
u(k)
y(k)

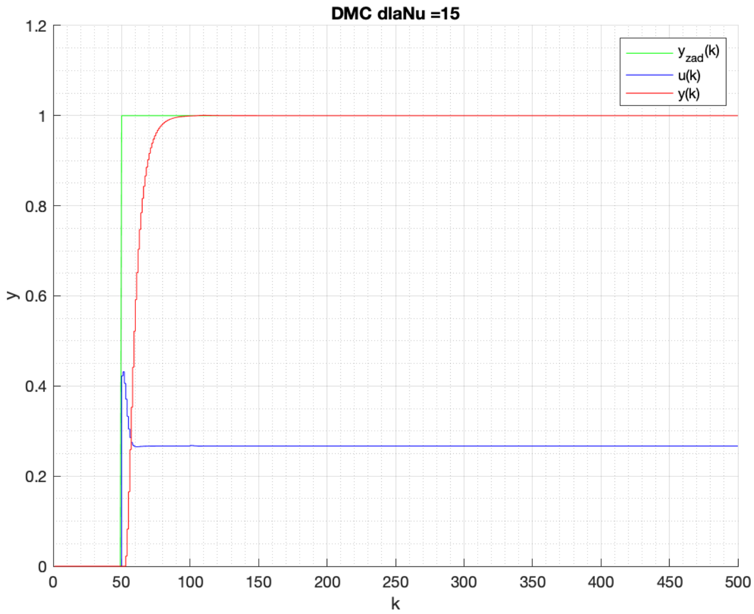

DMC dlaLambda =28
y
k
$y_{zad}(k)$
u(k)
y(k)

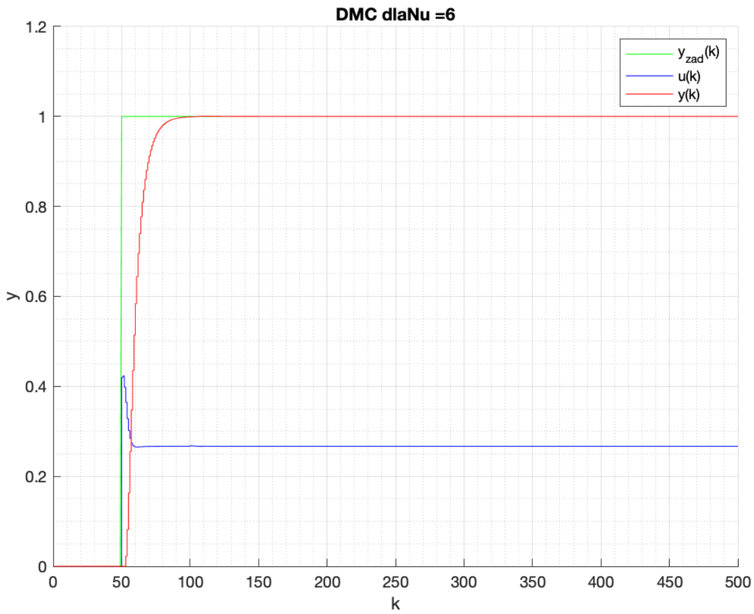

DMC dlaLambda =38
$y_{zad}(k)$
u(k)
y(k)
y
k

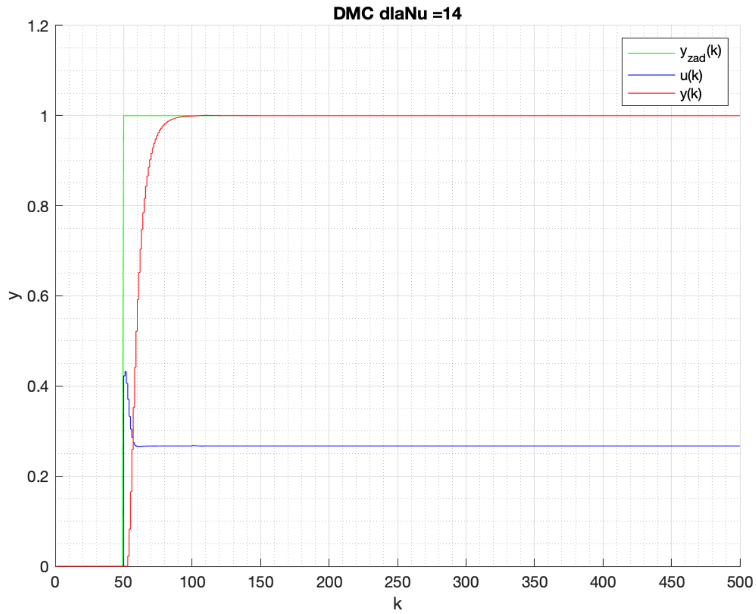

DMC dlaLambda =91
$y_{zad}(k)$
u(k)
y(k)
y
k

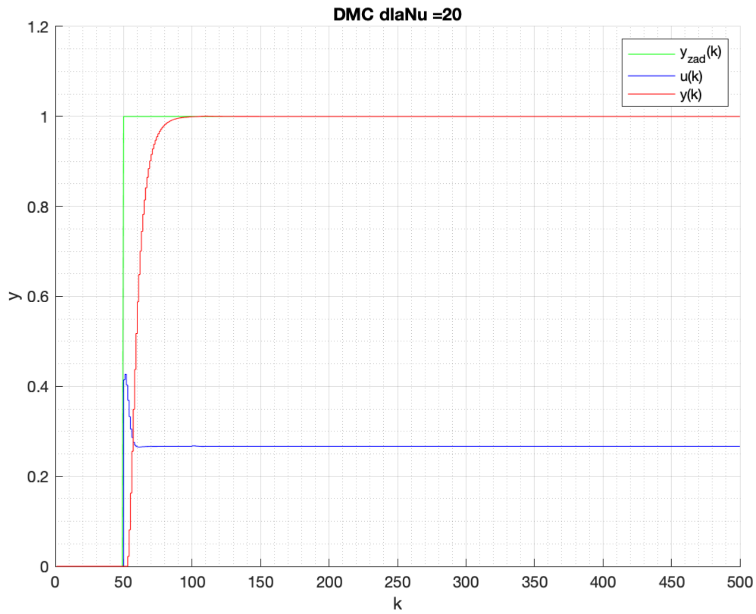

DMC dlaLambda =81
y
k
$y_{zad}(k)$
u(k)
y(k)

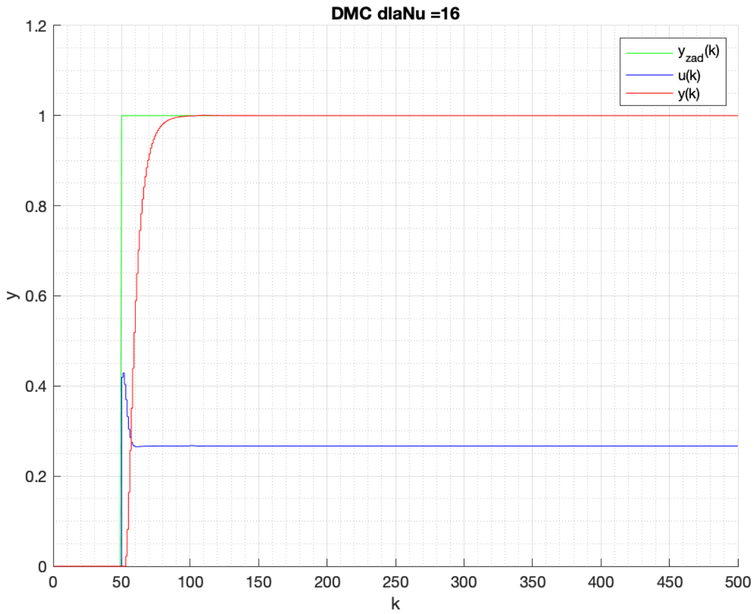

DMC dlaNu =7
y
k
$y_{zad}(k)$
u(k)
y(k)

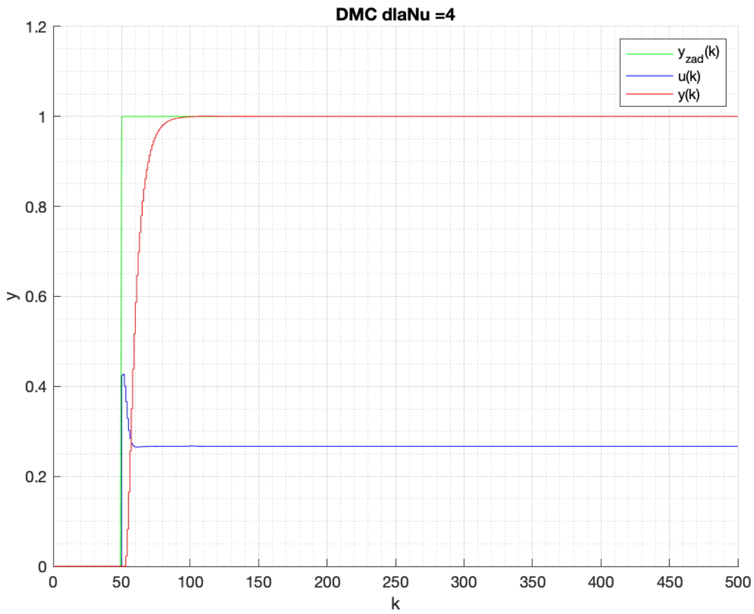

DMC dlaNu =15
y
k
$y_{zad}(k)$
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

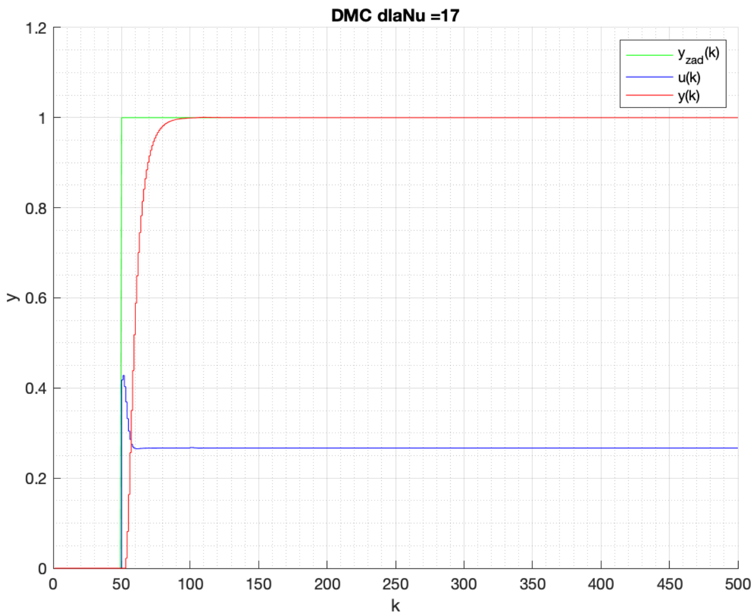

DMC dlaNu =6
y
k
$y_{zad}(k)$
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

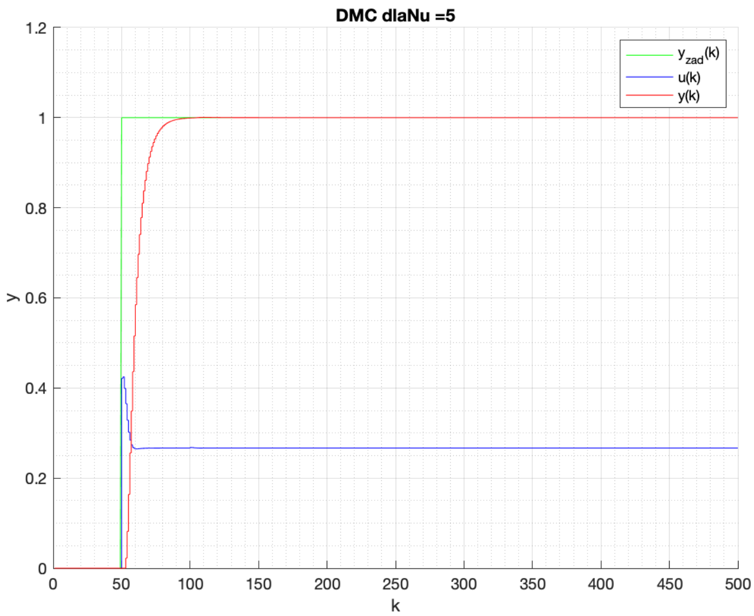

DMC dlaNu =14
y
k
yzad(k)
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
50
100
150
200
250
300
350
400
450
500

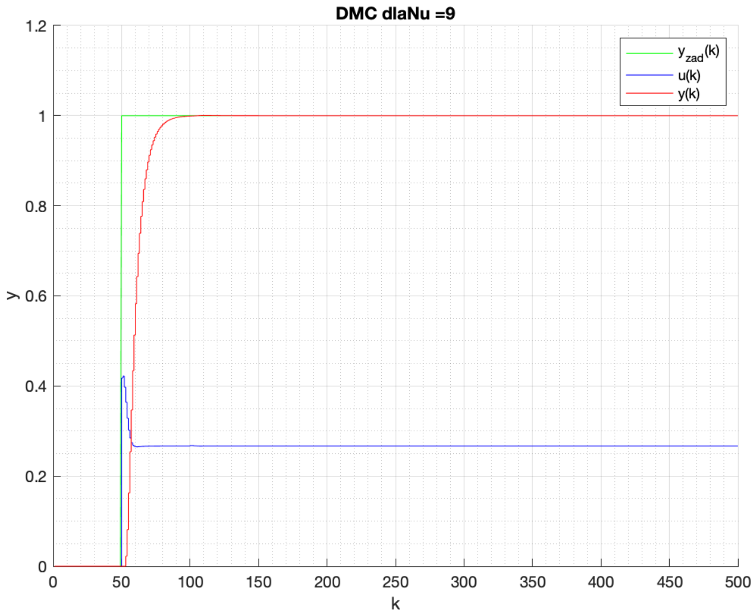

DMC dlaNu =20
y
k
yzad(k)
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
50
100
150
200
250
300
350
400
450
500

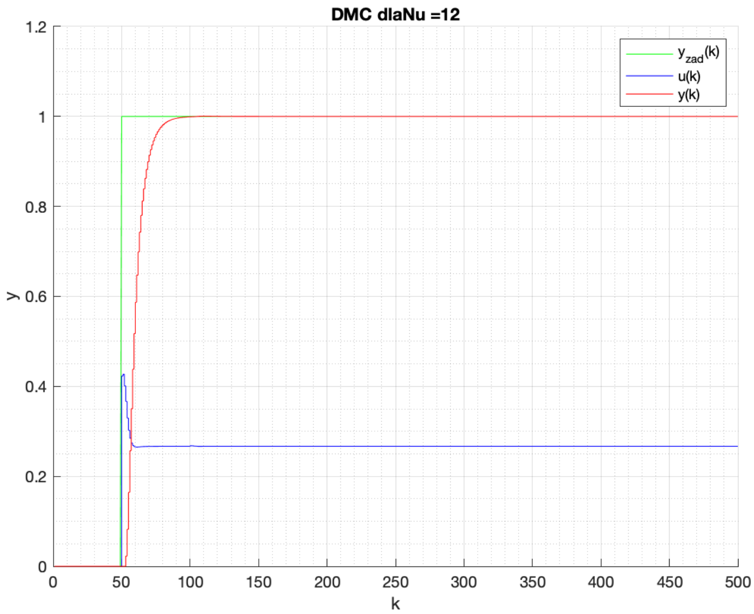

DMC dlaNu =16
y
k
$y_{zad}(k)$
u(k)
y(k)

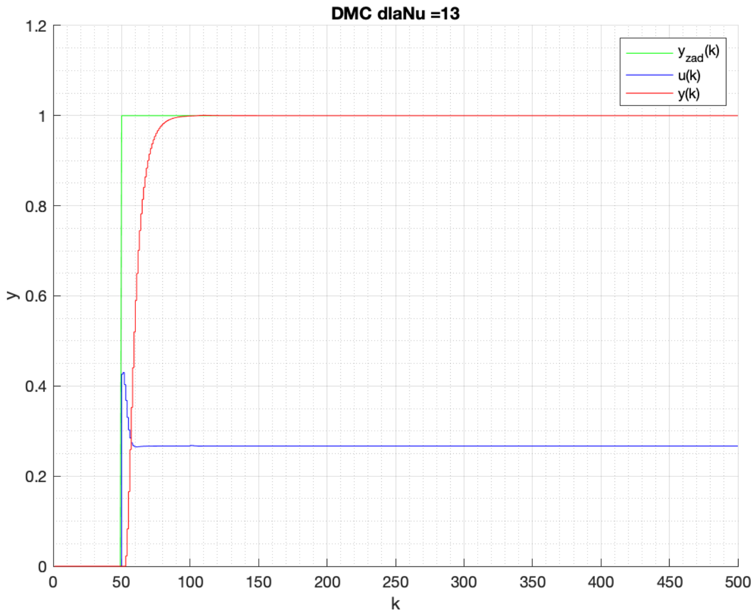

DMC dlaNu =4
y
k
$y_{zad}(k)$
u(k)
y(k)

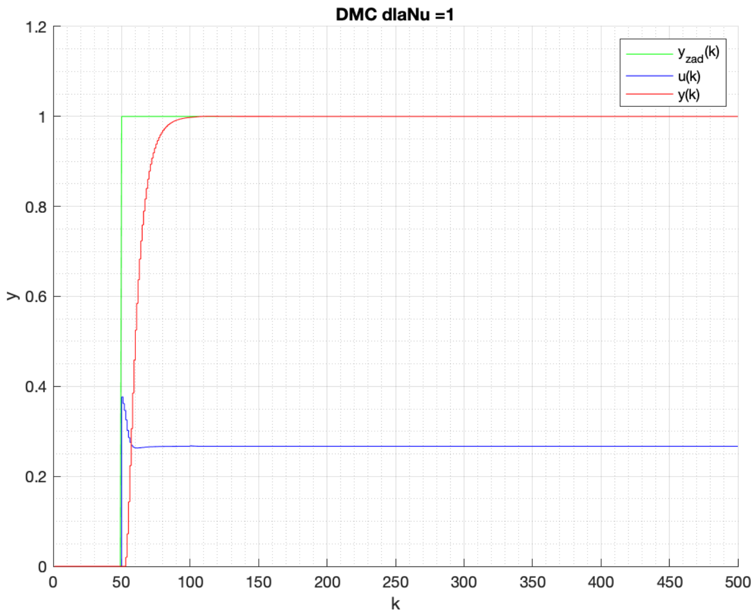

DMC dlaNu =17
y
k
$y_{zad}(k)$
u(k)
y(k)

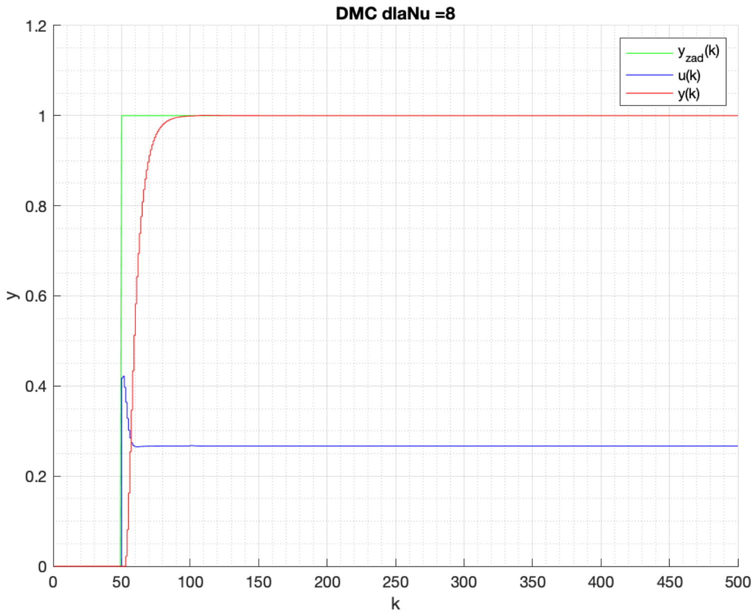

DMC dlaNu =5
y
k
$y_{zad}(k)$
u(k)
y(k)

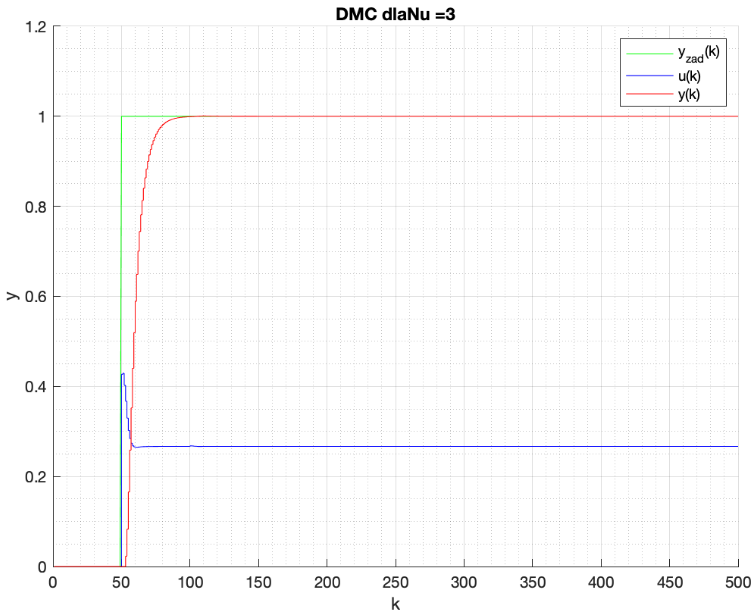

DMC dlaNu =9
y
k
y_zad(k)
u(k)
y(k)

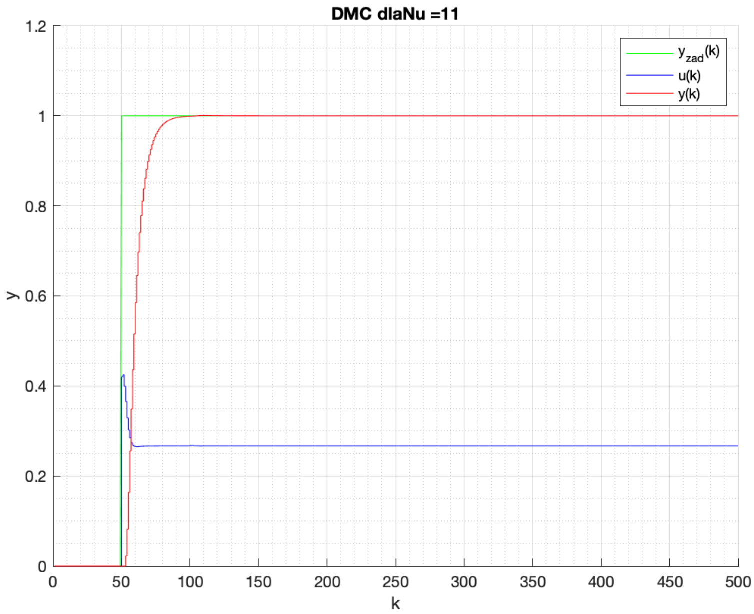

DMC dlaNu =12
y
k
y_zad(k)
u(k)
y(k)

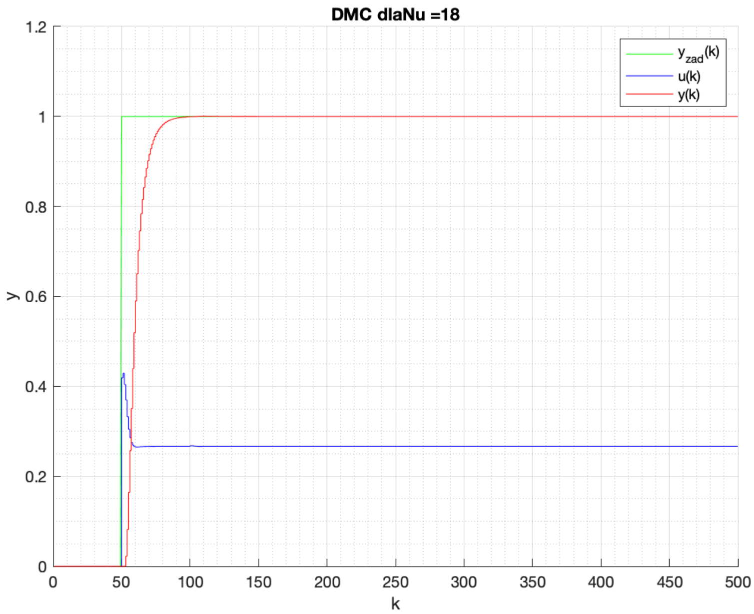

DMC dlaNu =13
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

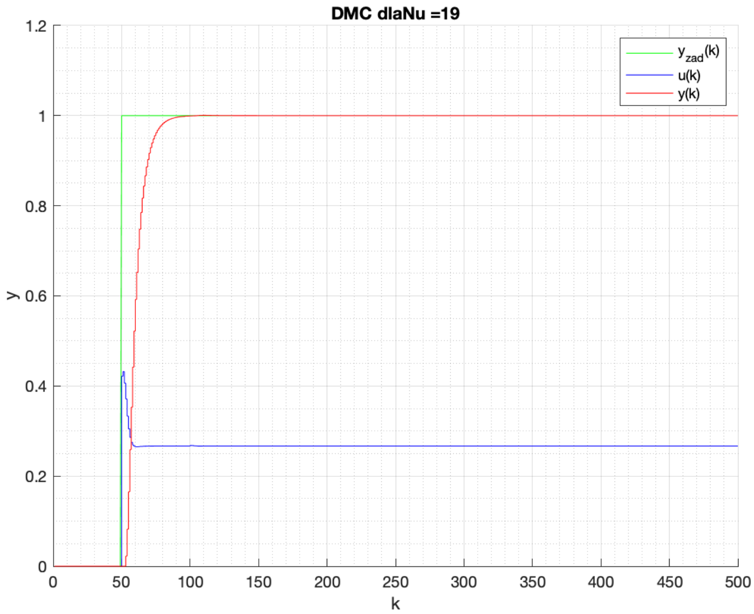

DMC dlaNu =1
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

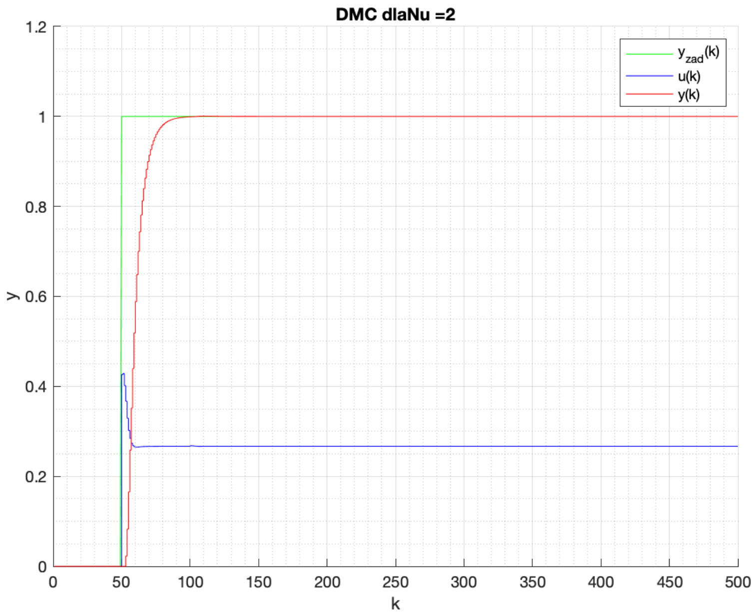

DMC dlaNu =8
y
k
$y_{zad}(k)$
u(k)
y(k)

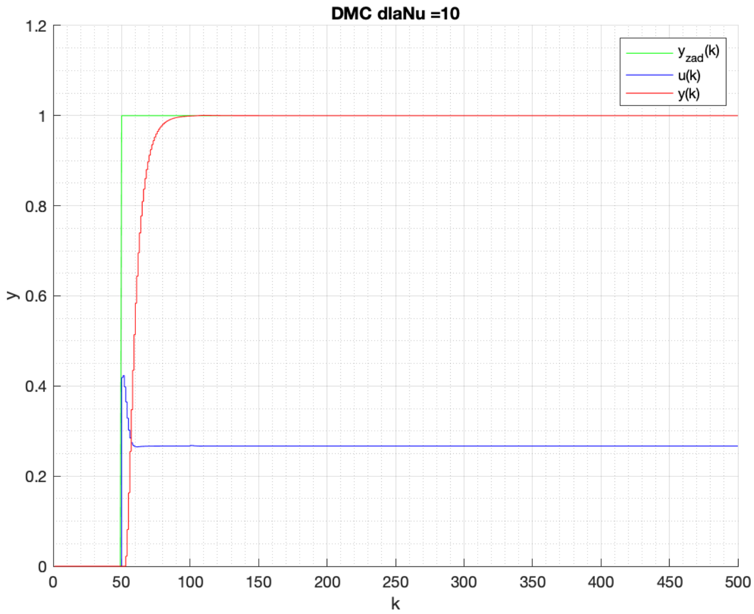

DMC dlaNu =3
y
k
$y_{zad}(k)$
u(k)
y(k)

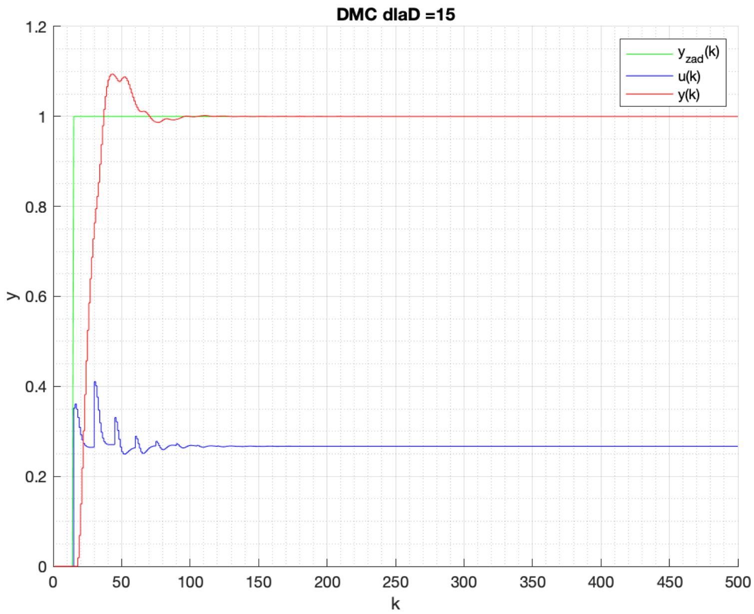

DMC dlaNu =11
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

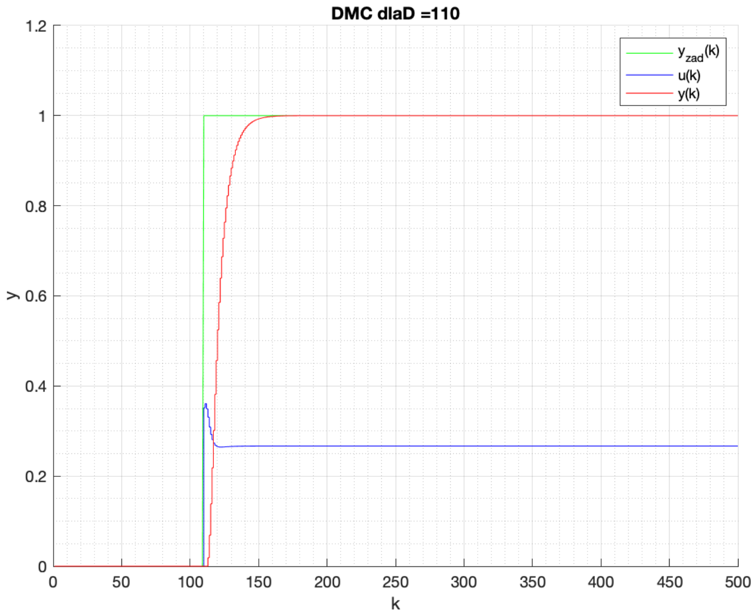

DMC dlaNu =18
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

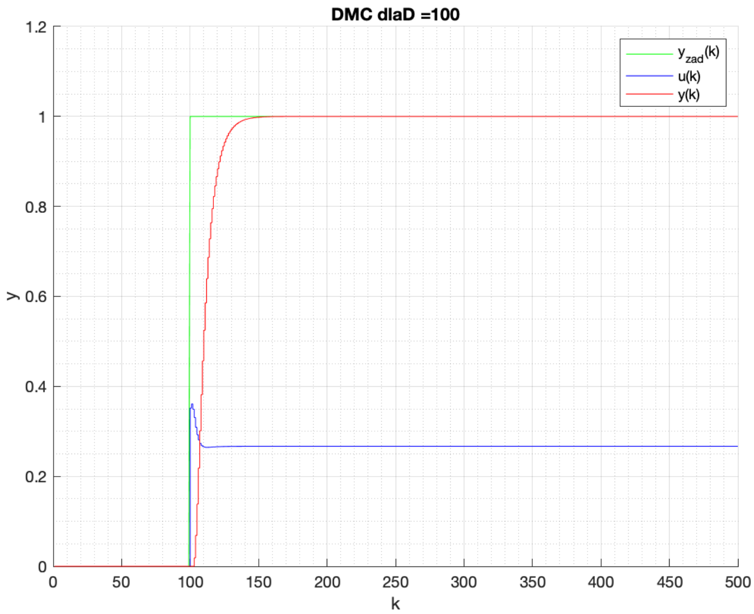

DMC dlaNu =19
y
k
$y_{zad}(k)$
u(k)
y(k)

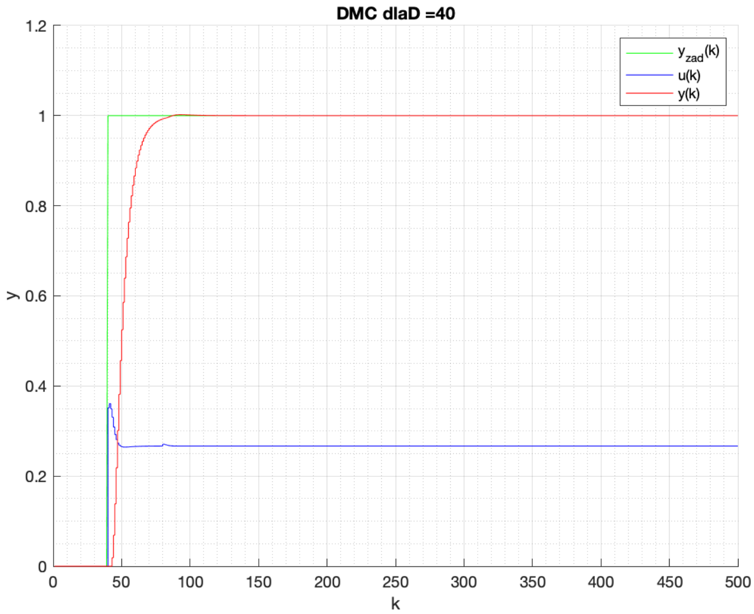

DMC dlaNu =2
y
k
$y_{zad}(k)$
u(k)
y(k)

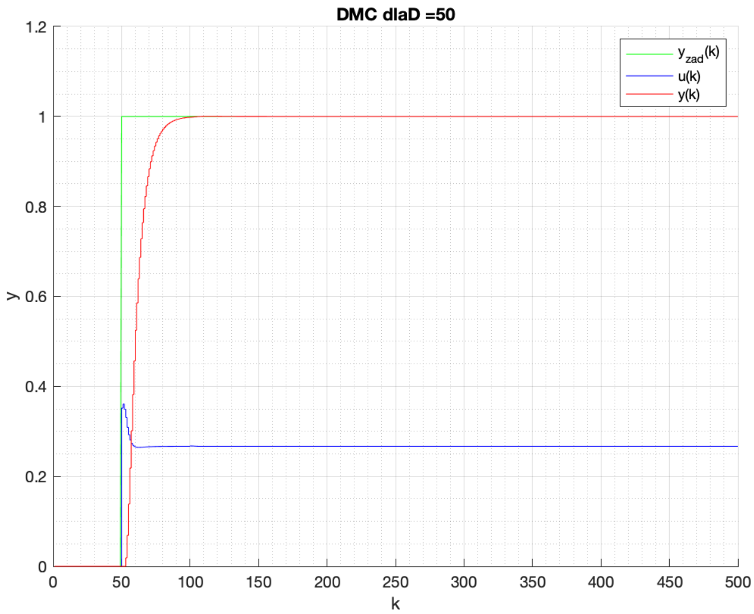

DMC dlaNu =10
$y_{zad}(k)$
u(k)
y(k)
y
k

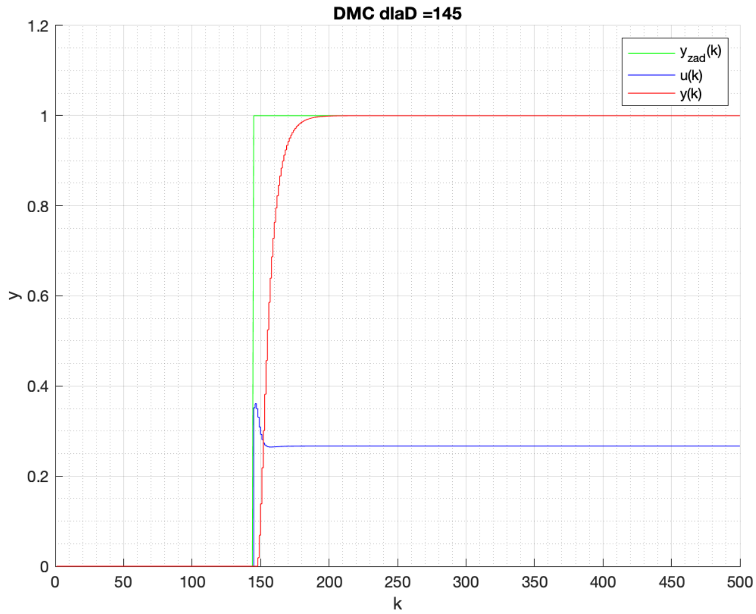

DMC dlaD =15
$y_{zad}(k)$
u(k)
y(k)
y
k

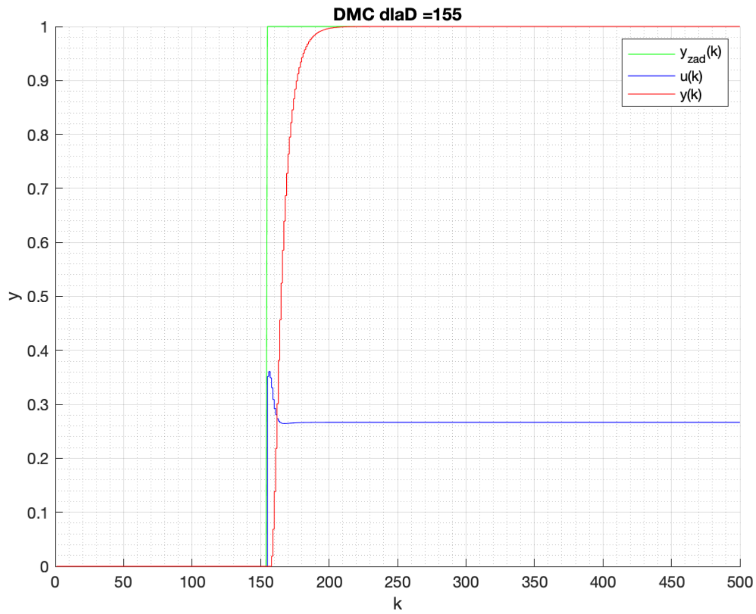

DMC dlaD =110
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

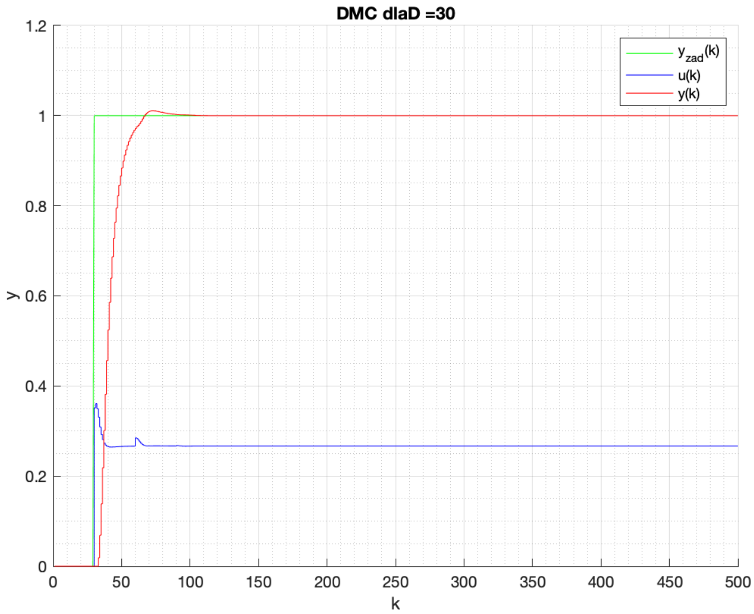

DMC dlaD =100
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

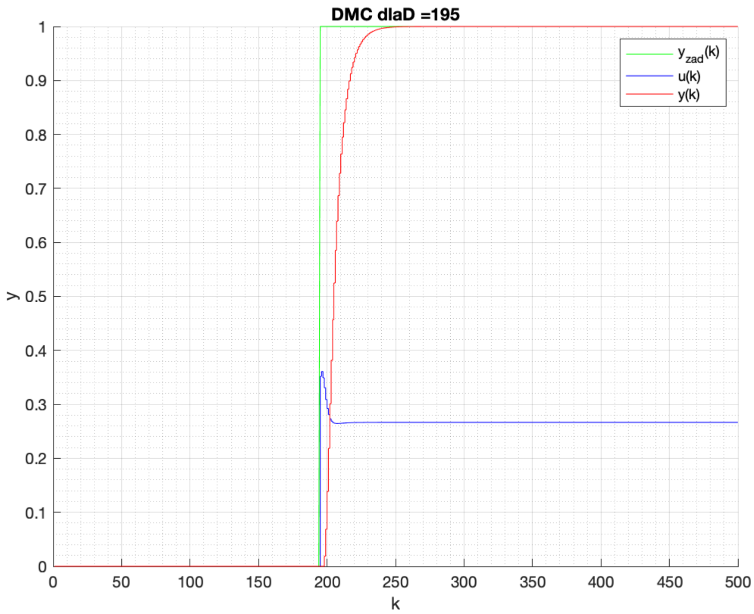

DMC dlaD =40
y
k
$y_{zad}(k)$
u(k)
y(k)

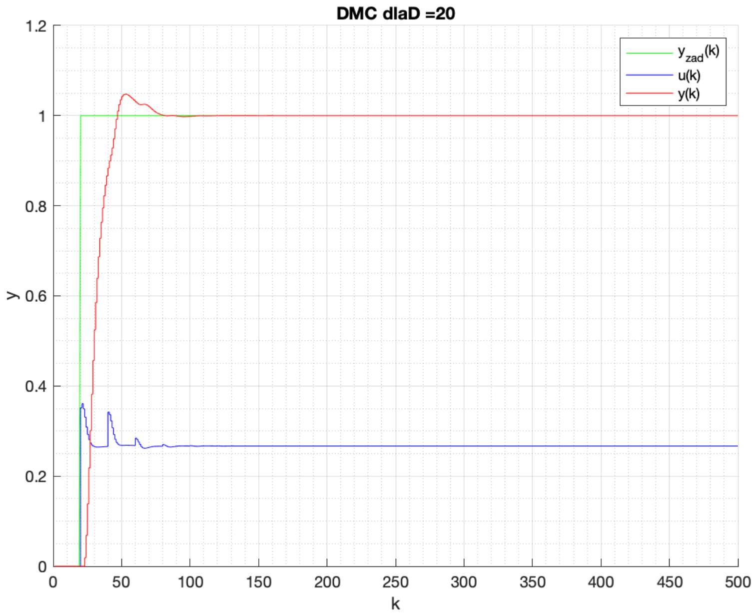

DMC dlaD =50
y
k
$y_{zad}(k)$
u(k)
y(k)

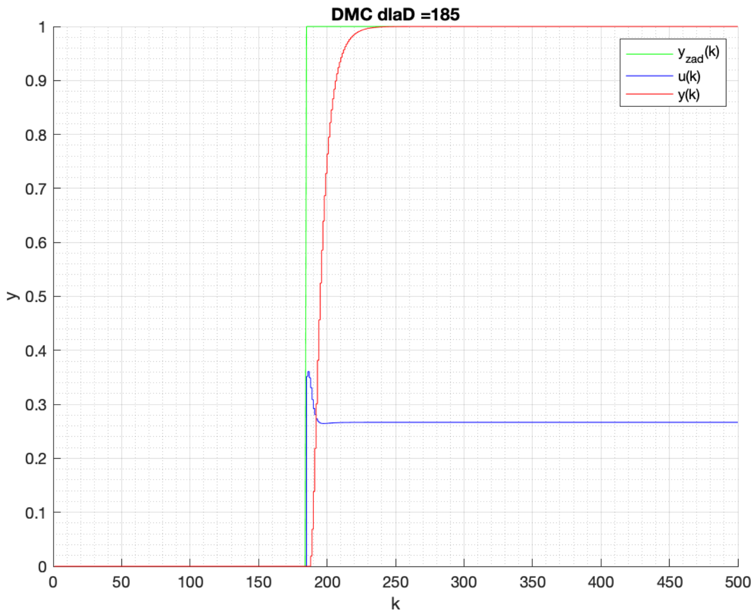

DMC dlaD =145
y_{zad}(k)
u(k)
y(k)
y
k

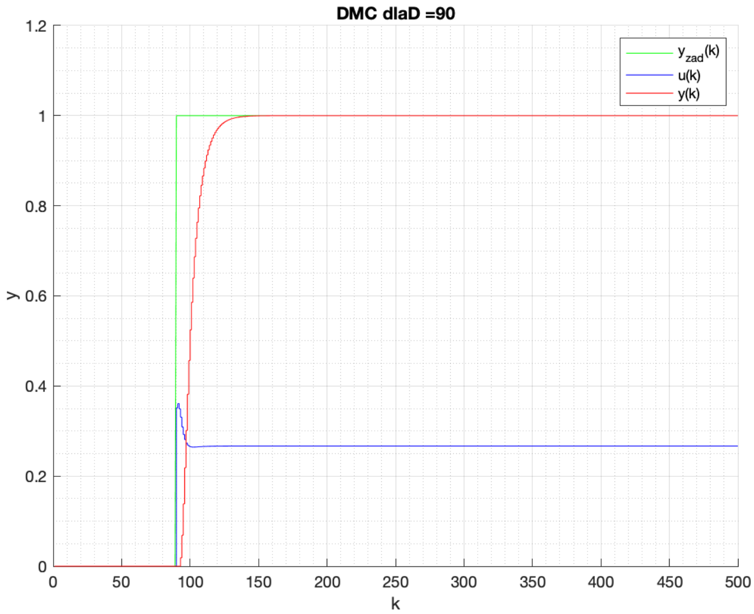

DMC dlaD =155
y_{zad}(k)
u(k)
y(k)
y
k

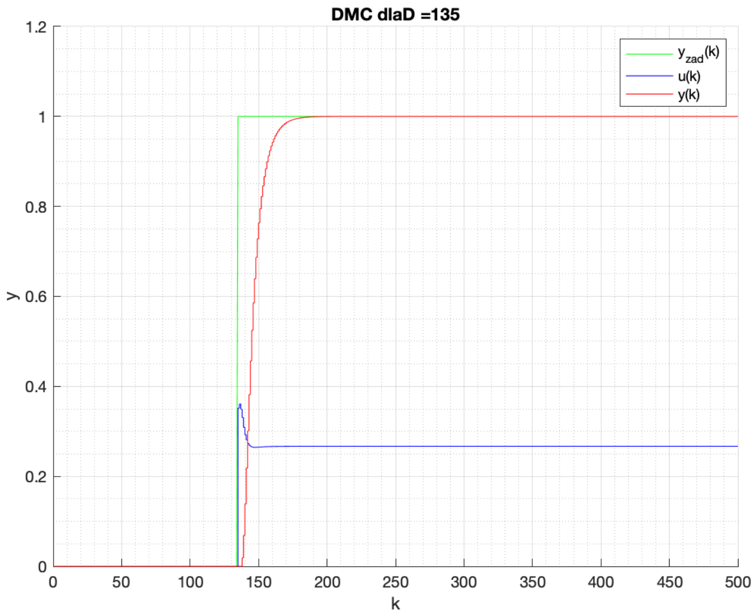

DMC dlaD =30
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

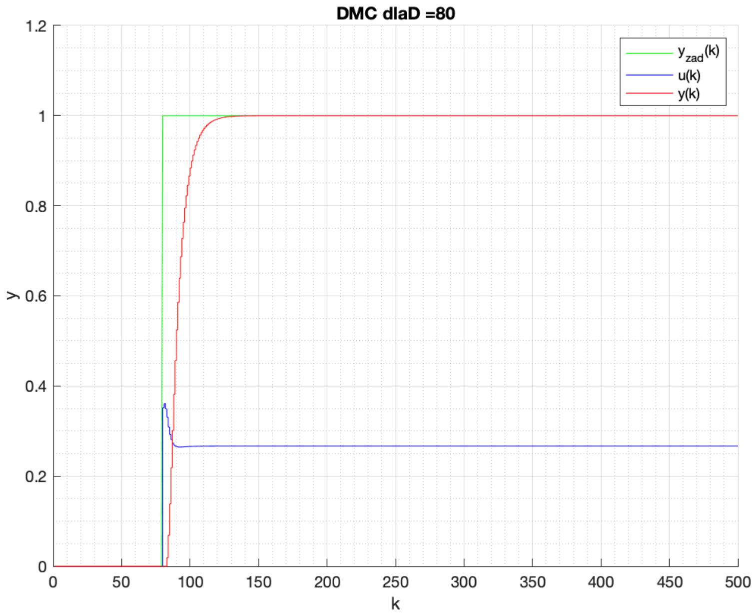

DMC dlaD =195
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

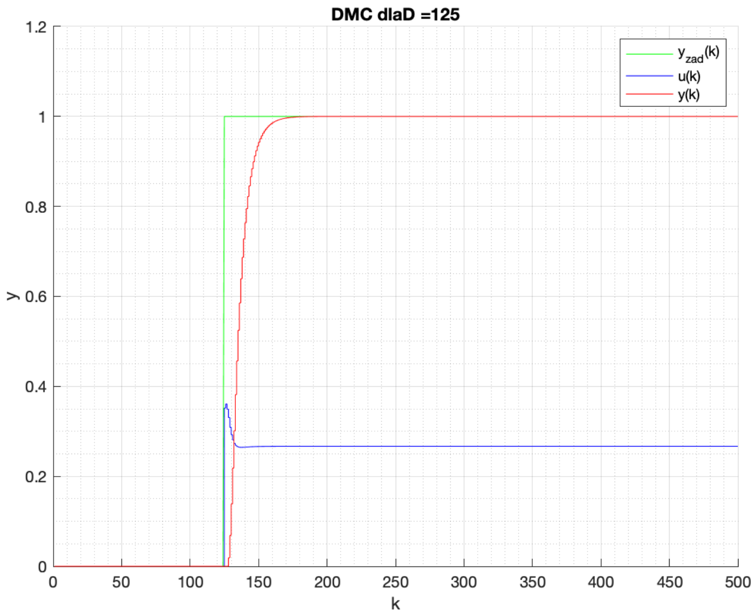

DMC dlaD =20
$y_{zad}(k)$
u(k)
y(k)
y
k

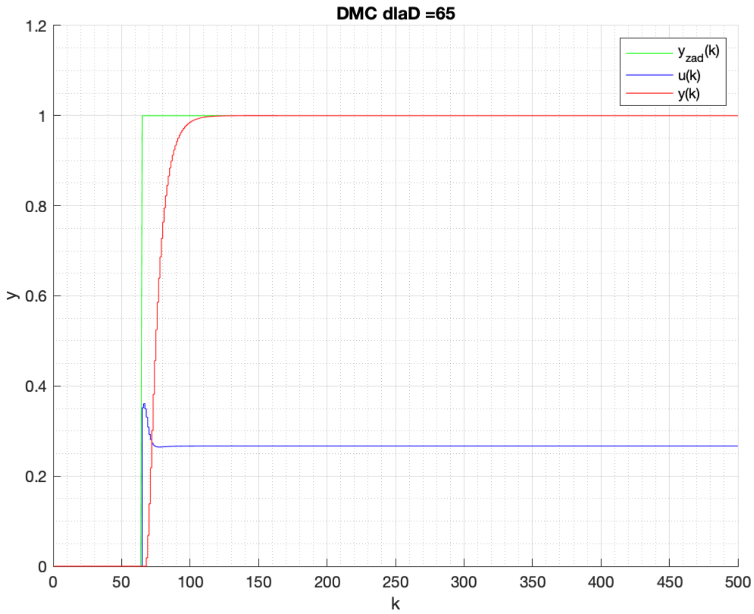

DMC dlaD =185
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dlaD =90
y
k
$y_{zad}(k)$
u(k)
y(k)

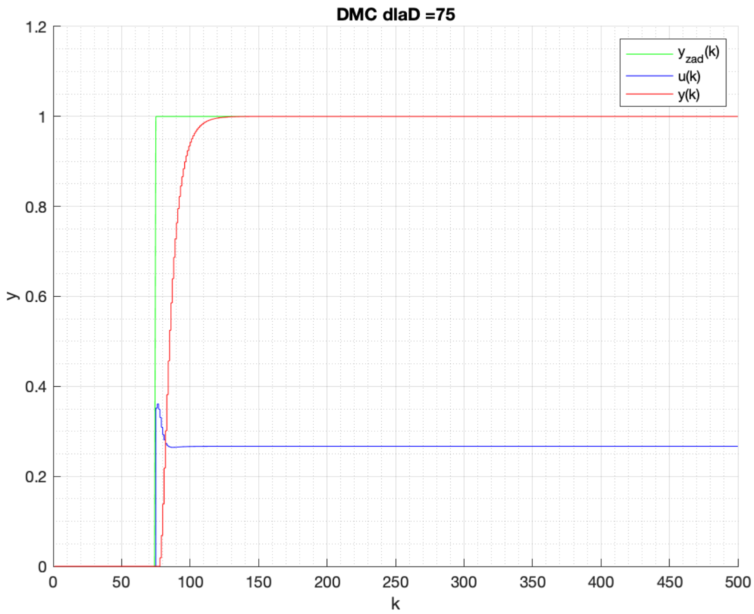

DMC dlaD =135
y
k
$y_{zad}(k)$
u(k)
y(k)


DMC dlaD =80
y
k
$y_{zad}(k)$
u(k)
y(k)

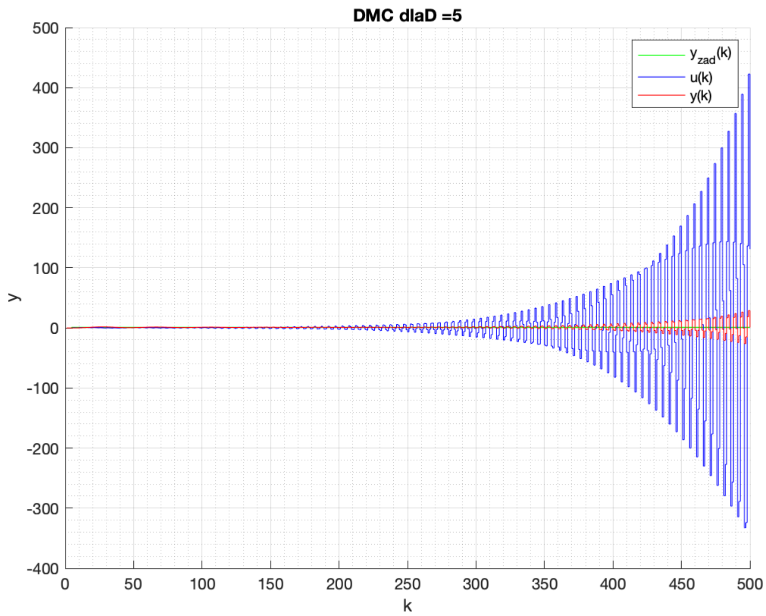

DMC dlaD =125
y
k
$y_{zad}(k)$
u(k)
y(k)

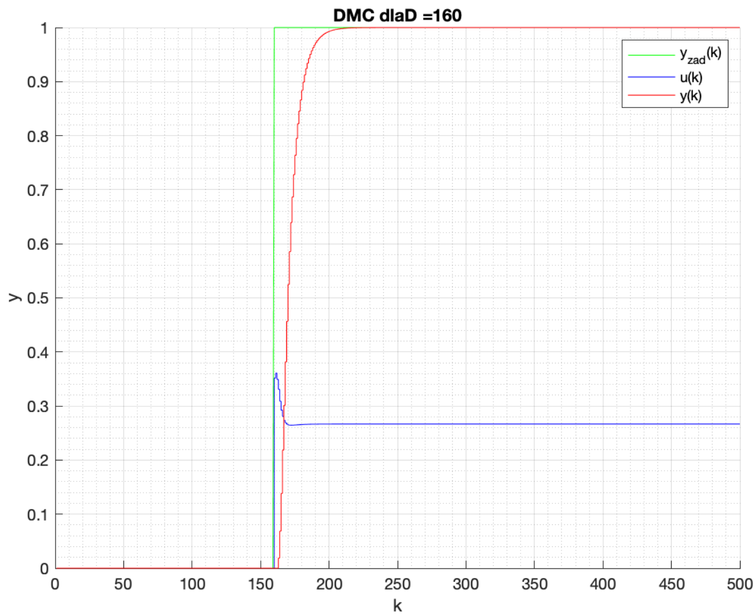


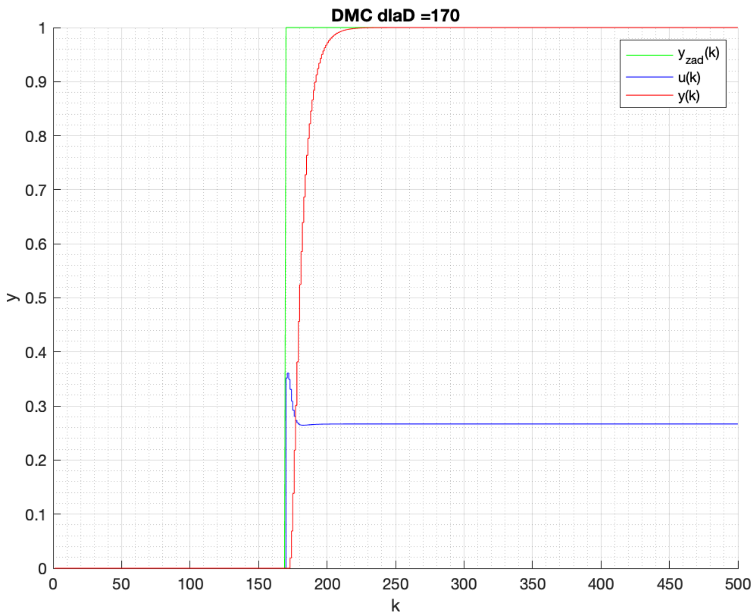
DMC dlaD =65
$y_{zad}(k)$
u(k)
y(k)
y
k

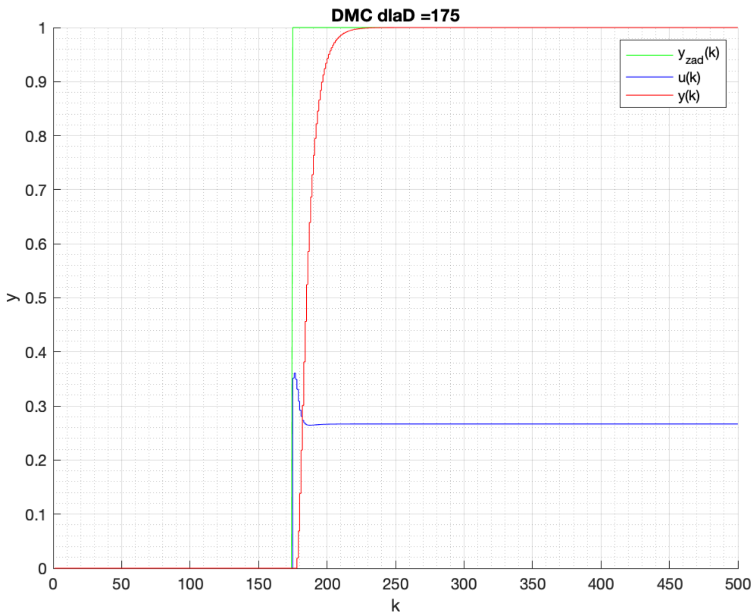


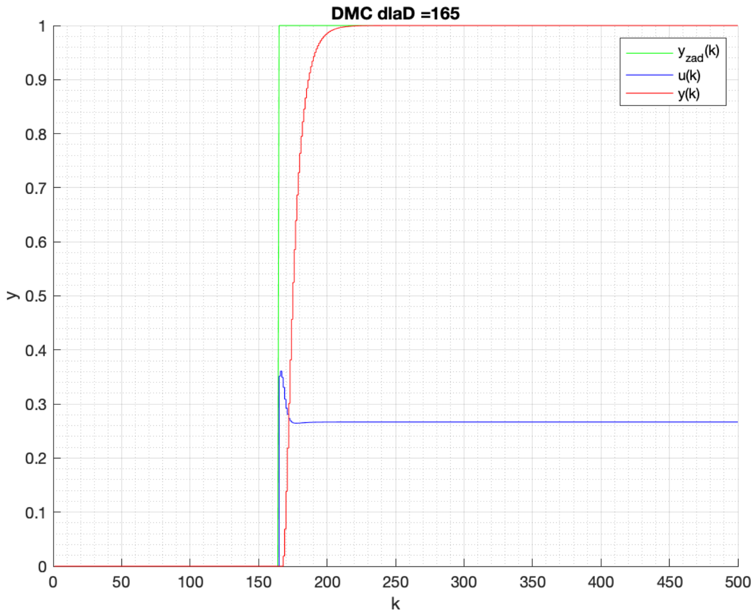
DMC dlaD =75
$y_{zad}(k)$
u(k)
y(k)
y
k

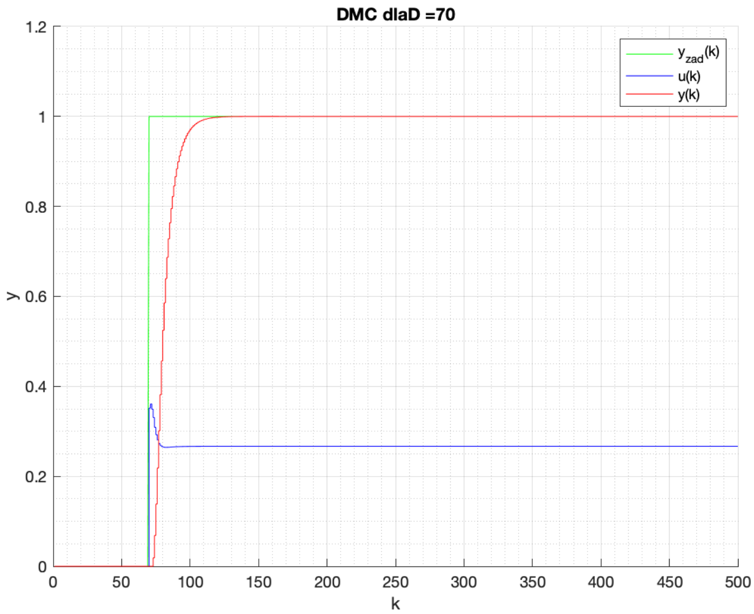

DMC dlaD =5
$y_{zad}(k)$
u(k)
y(k)
y
k
500
400
300
200
100
0
-100
-200
-300
-400
0
50
100
150
200
250
300
350
400
450
500

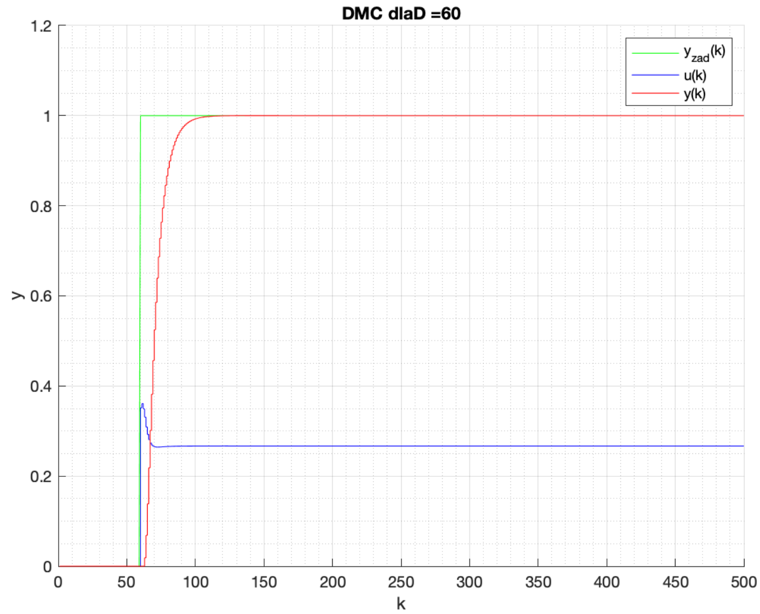

DMC dlaD =160
$y_{zad}(k)$
u(k)
y(k)
y
k
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
200
250
300
350
400
450
500

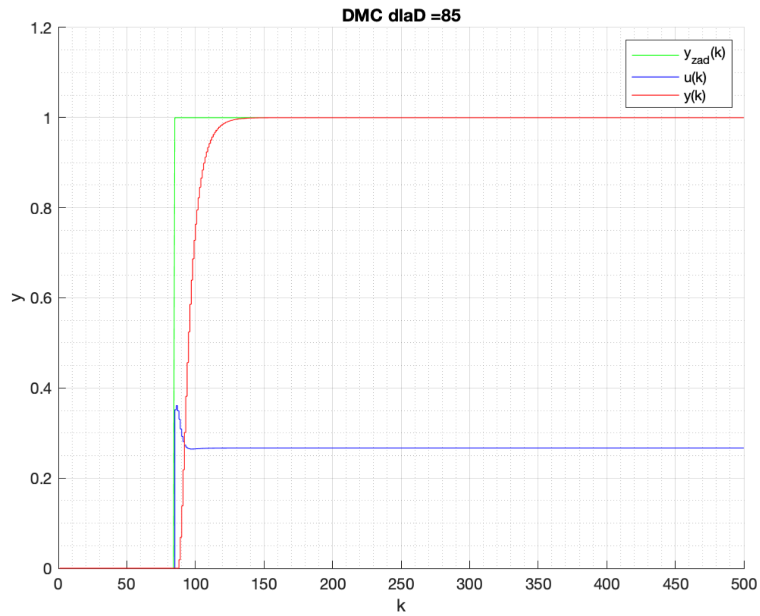

DMC dlaD =170
y
k
$y_{zad}(k)$
u(k)
y(k)

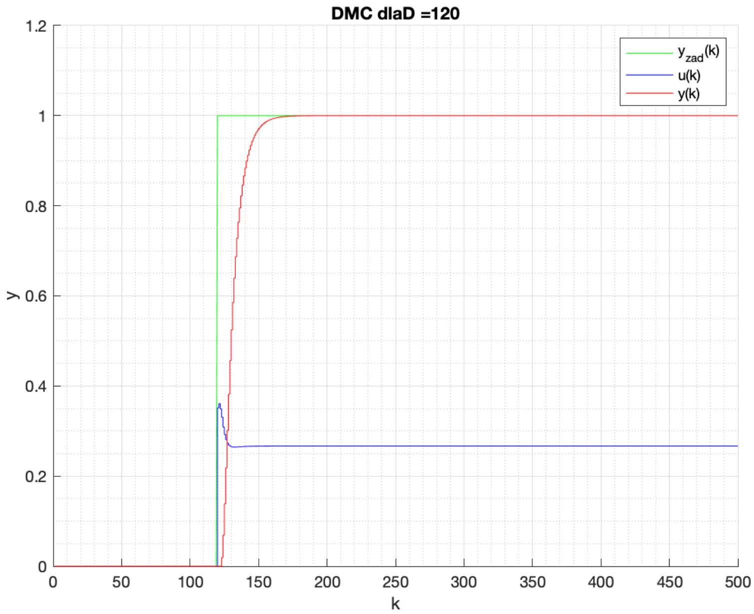

DMC dlaD =175
y
k
$y_{zad}(k)$
u(k)
y(k)

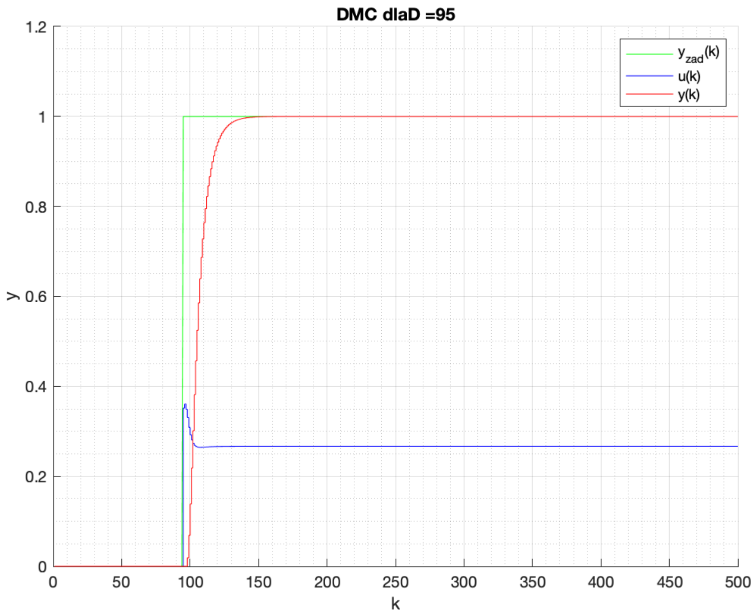

DMC dlaD =165
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
50
100
150
200
250
300
350
400
450
500

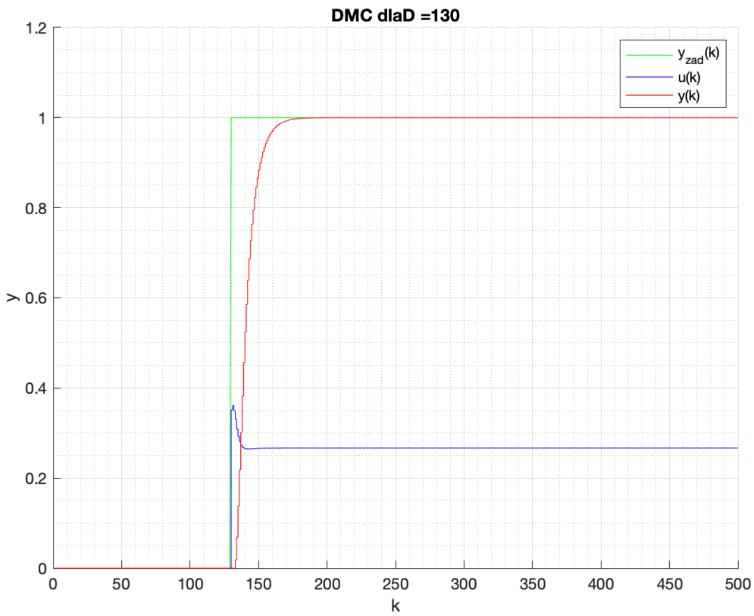

DMC dlaD =70
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

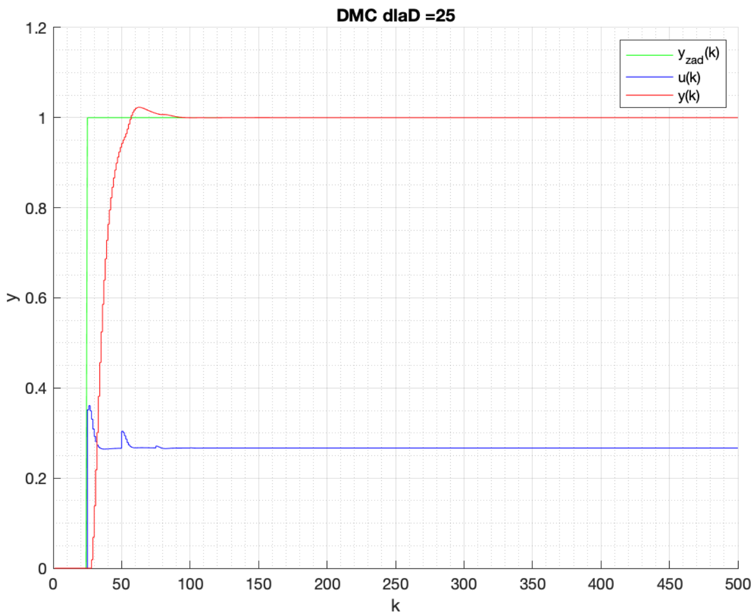

DMC dlaD =60
y
k
$y_{zad}(k)$
u(k)
y(k)

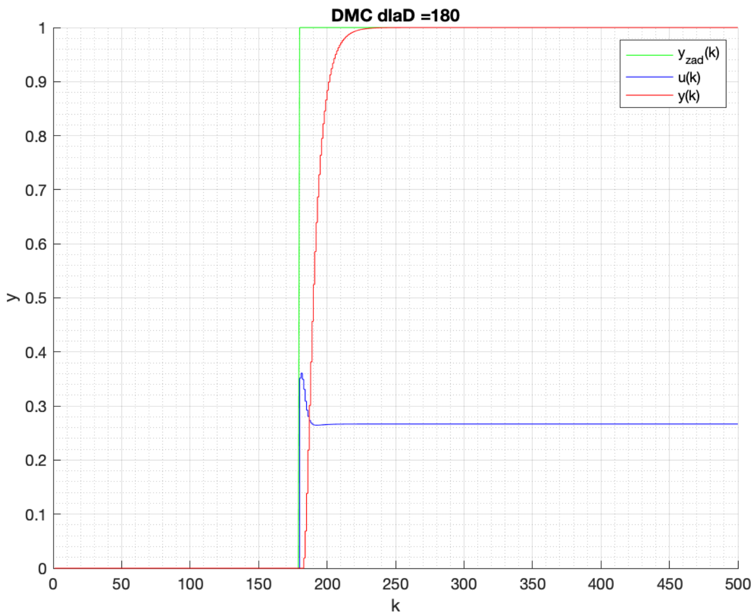

DMC dlaD =85
y
k
$y_{zad}(k)$
u(k)
y(k)

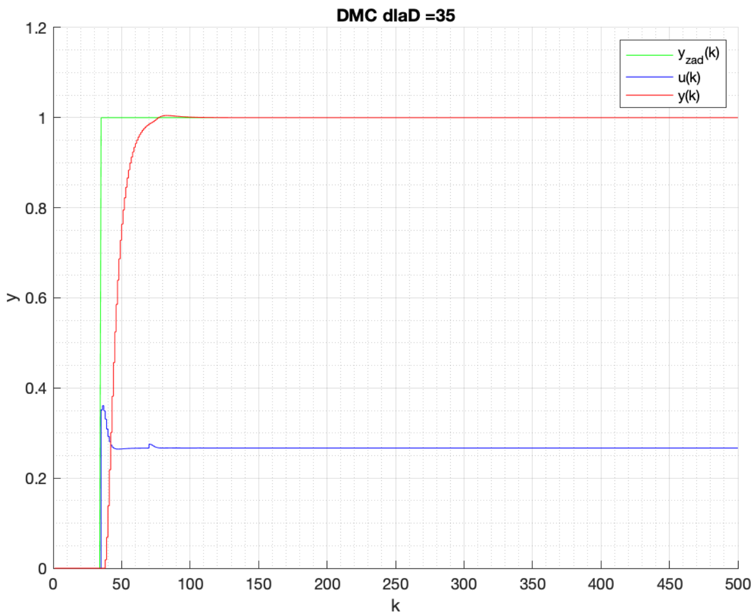

DMC dlaD =120
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

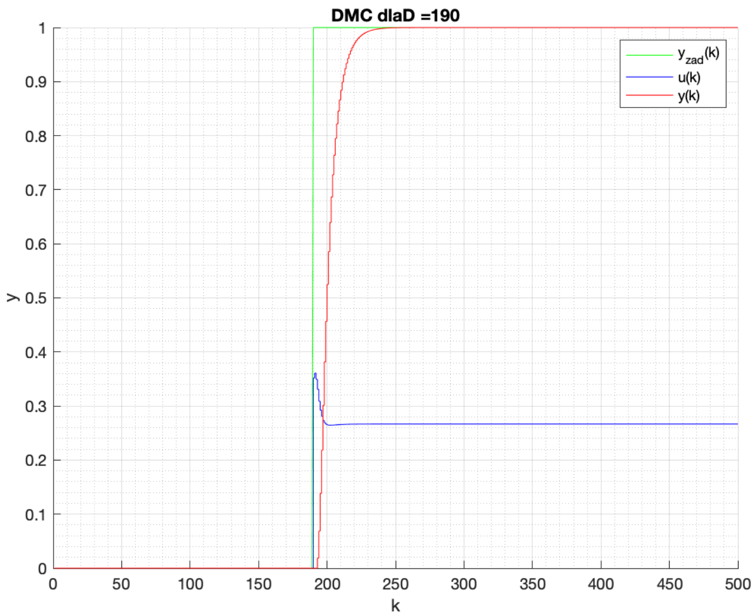

DMC dlaD =95
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

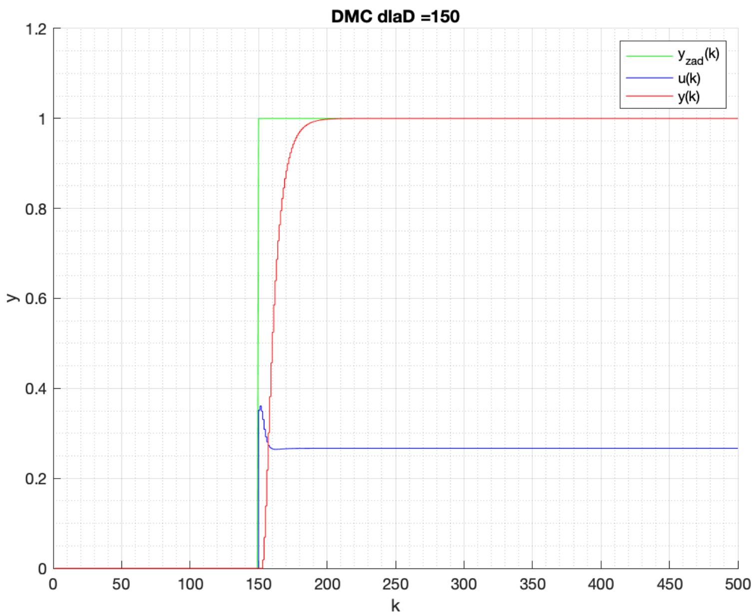

DMC dlaD =130
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

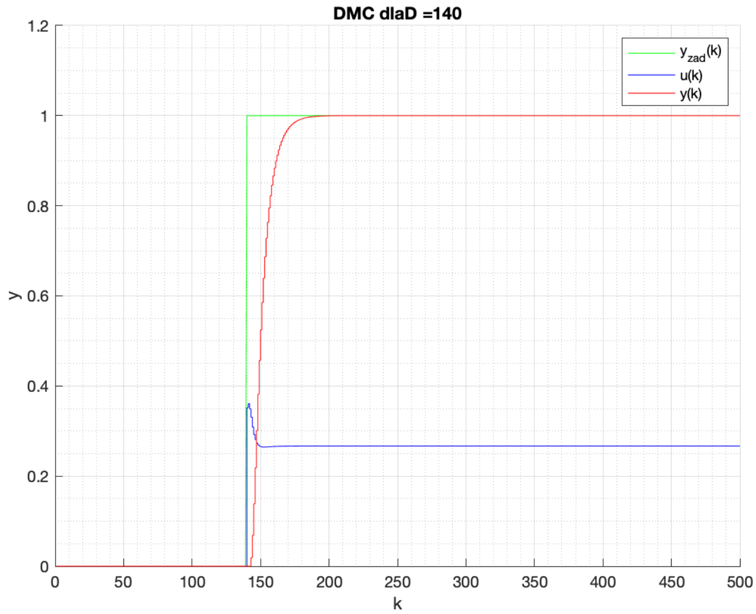

DMC dlaD =25
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

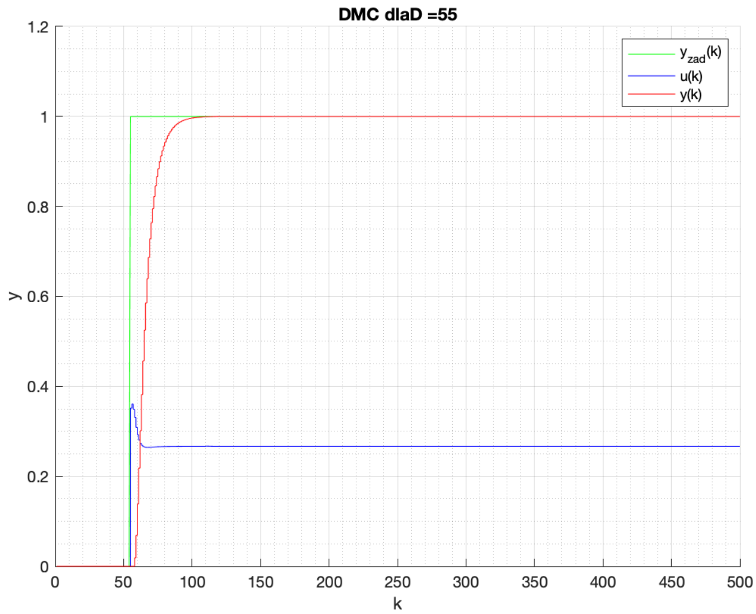

DMC dlaD =180
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

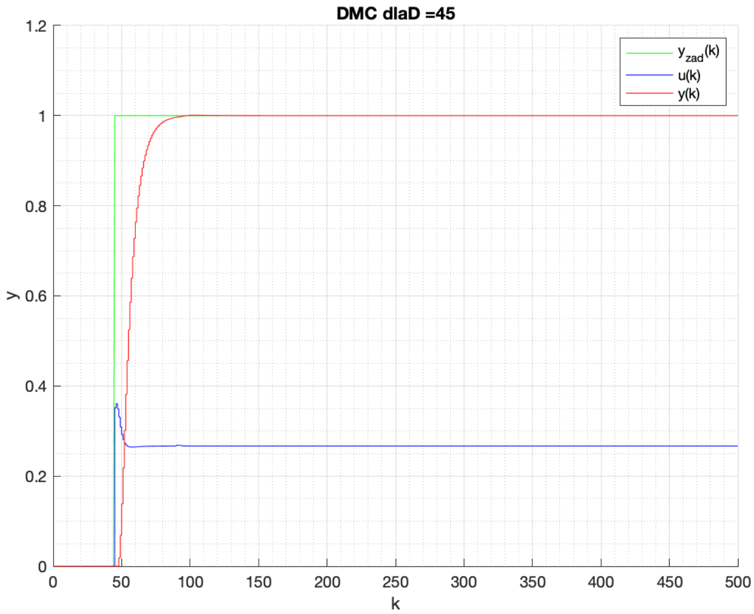

DMC dlaD =35
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

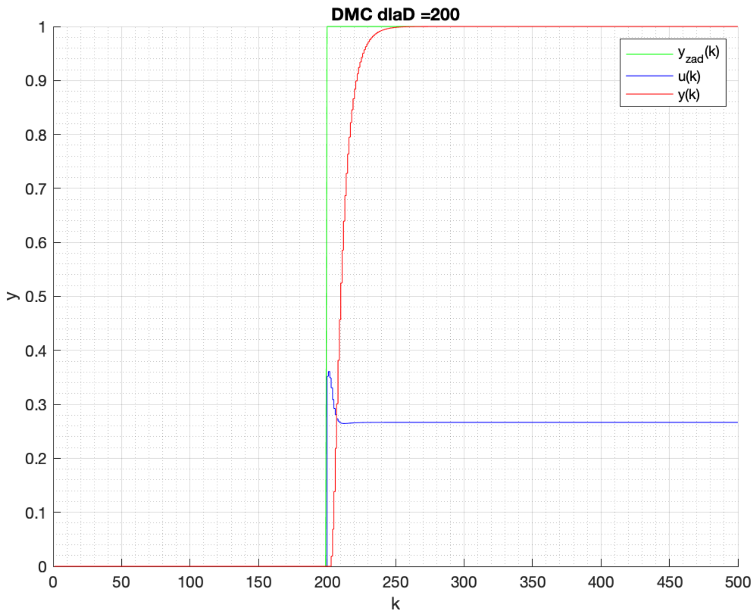

DMC dlaD =190
y
k
yzad(k)
u(k)
y(k)

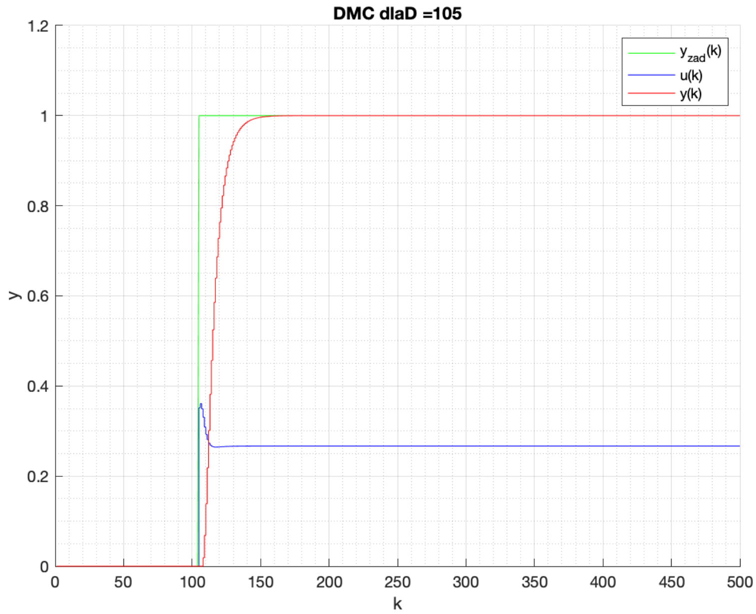

DMC dlaD =150
y
k
yzad(k)
u(k)
y(k)

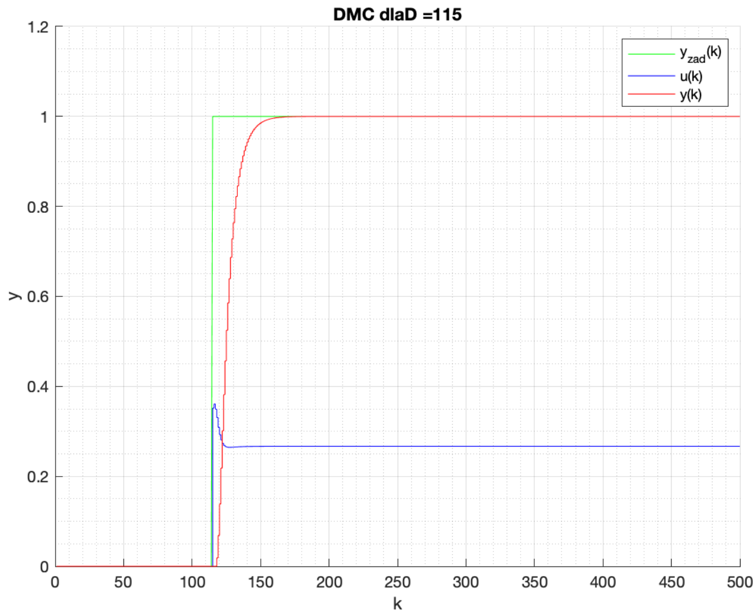

DMC dlaD =140
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

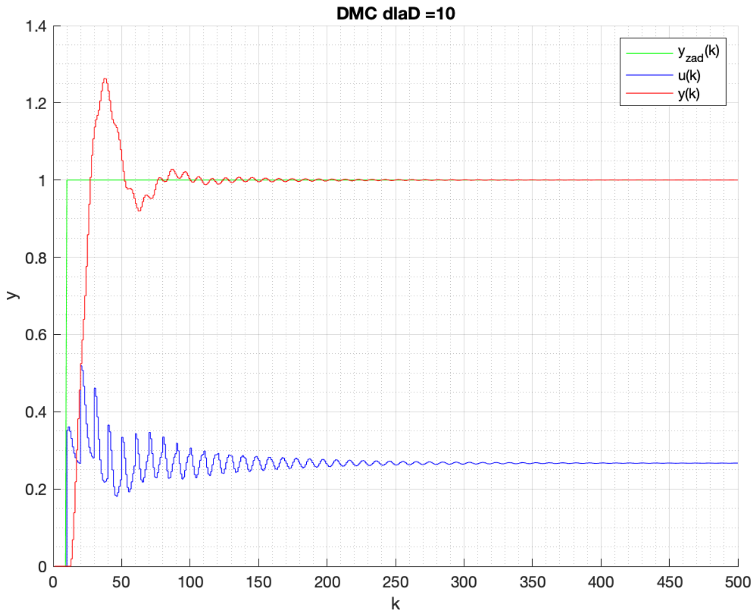

DMC dlaD =55
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

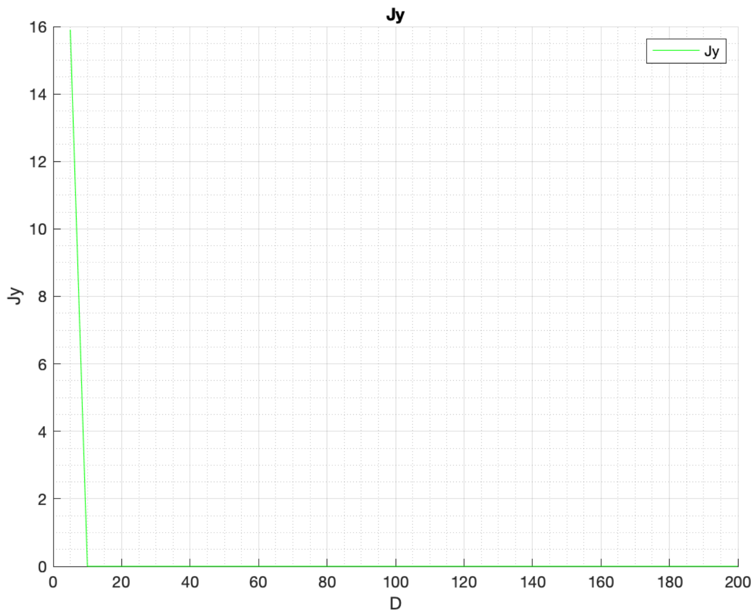

DMC dlaD =45
y
k
$y_{zad}(k)$
u(k)
y(k)

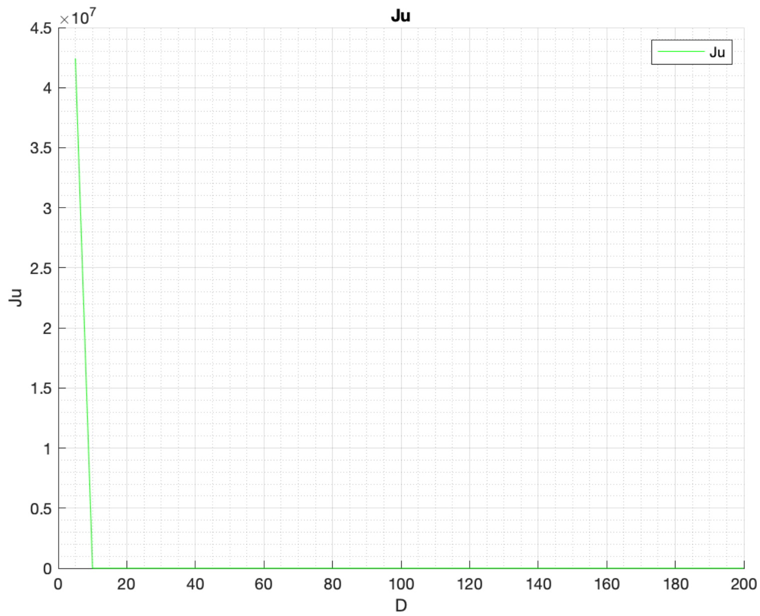

DMC dlaD =200
y
k
$y_{zad}(k)$
u(k)
y(k)

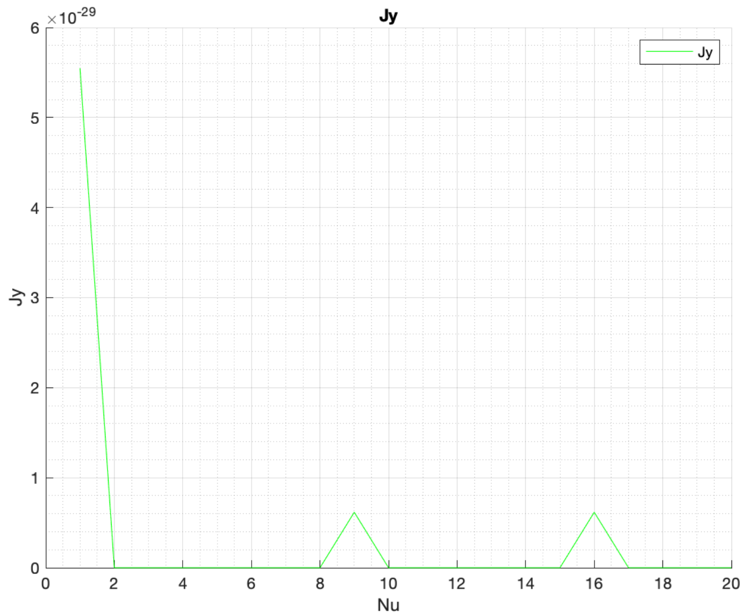

DMC dlaD =105
y
k
$y_{zad}(k)$
u(k)
y(k)

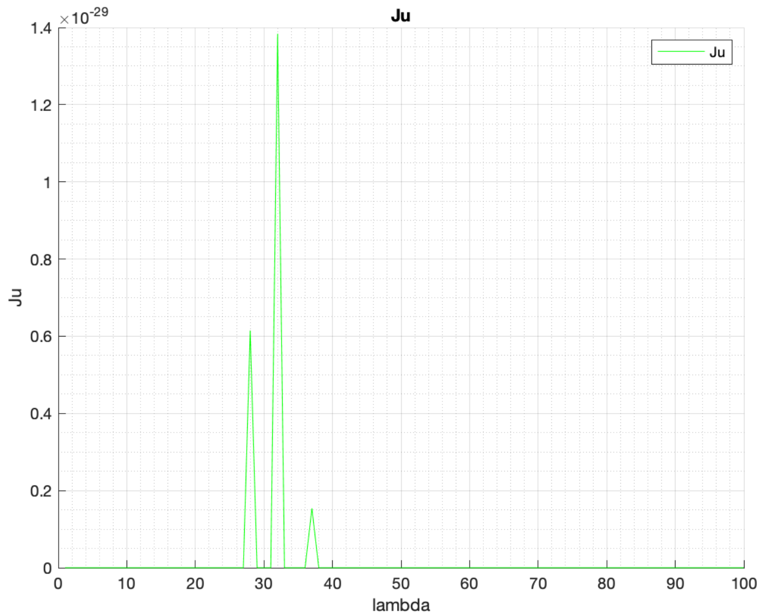

DMC dlaD =115
y
k
$y_{zad}(k)$
u(k)
y(k)


DMC dlaD =10
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2
1.4

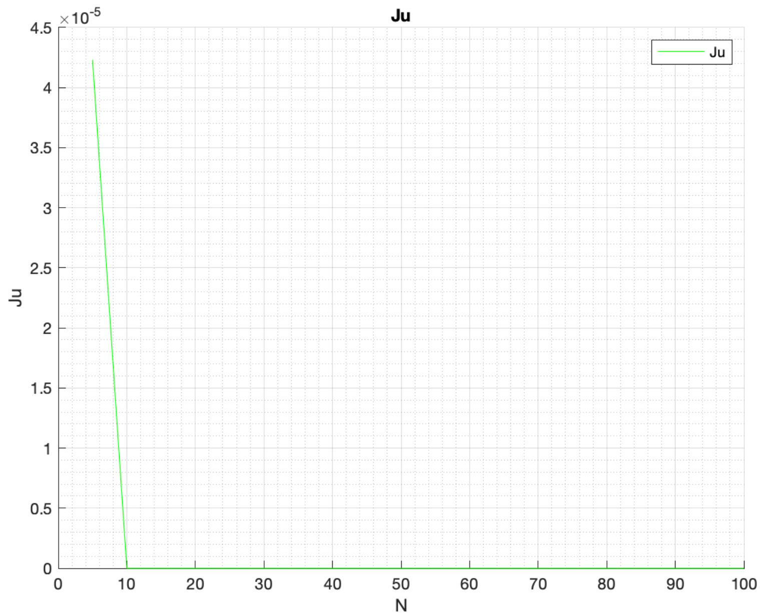

Jy
Jy
Jy
D
0
20
40
60
80
100
120
140
160
180
200
0
2
4
6
8
10
12
14
16


Ju
×10^7
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Ju
0
20
40
60
80
100
120
140
160
180
200
D
Ju

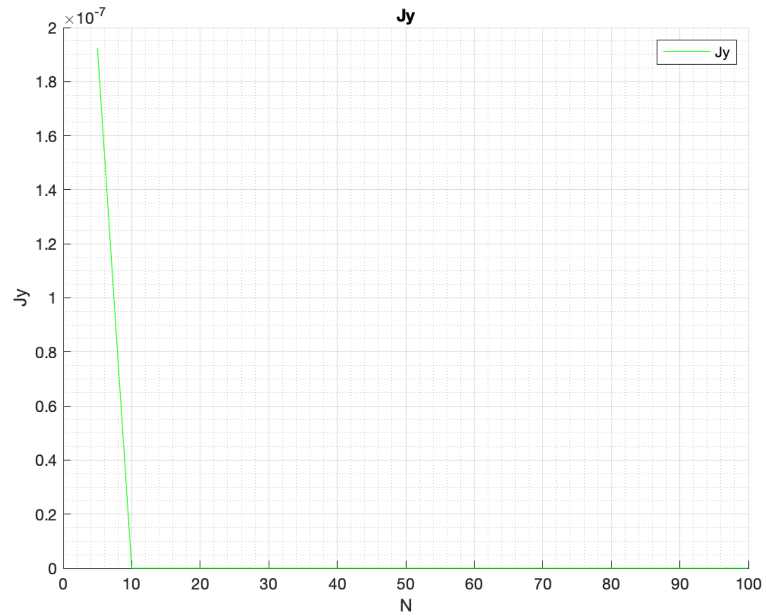

Jy
×10^-29
6
5
4
3
2
1
0
Jy
0
2
4
6
8
10
12
14
16
18
20
Nu
Jy

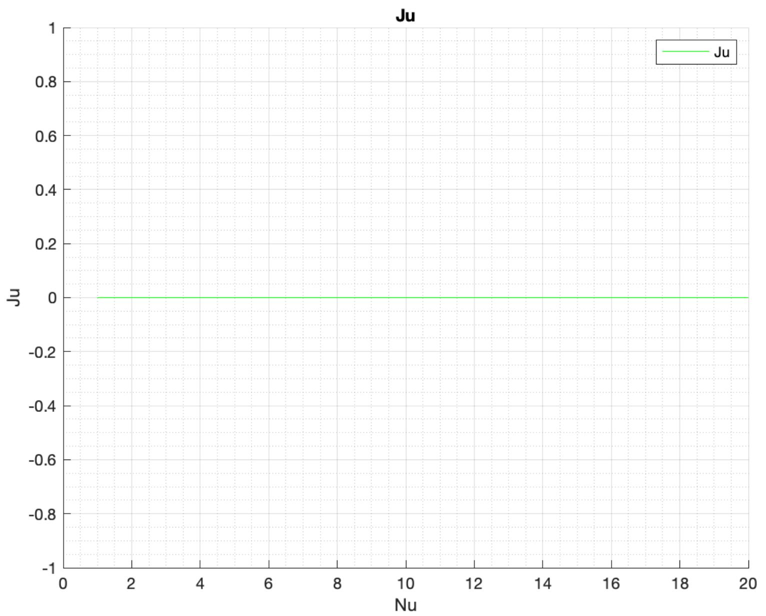


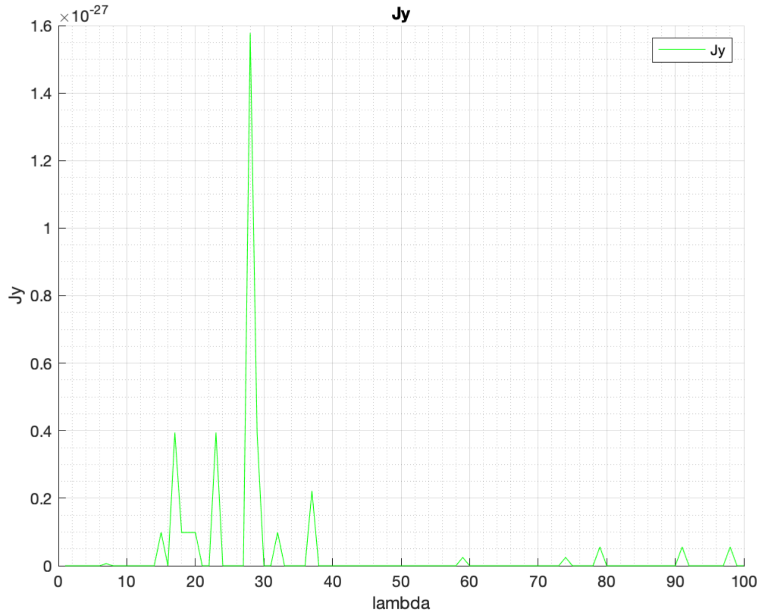
Ju
$\times 10^{-29}$
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Ju
0
10
20
30
40
50
60
70
80
90
100
lambda



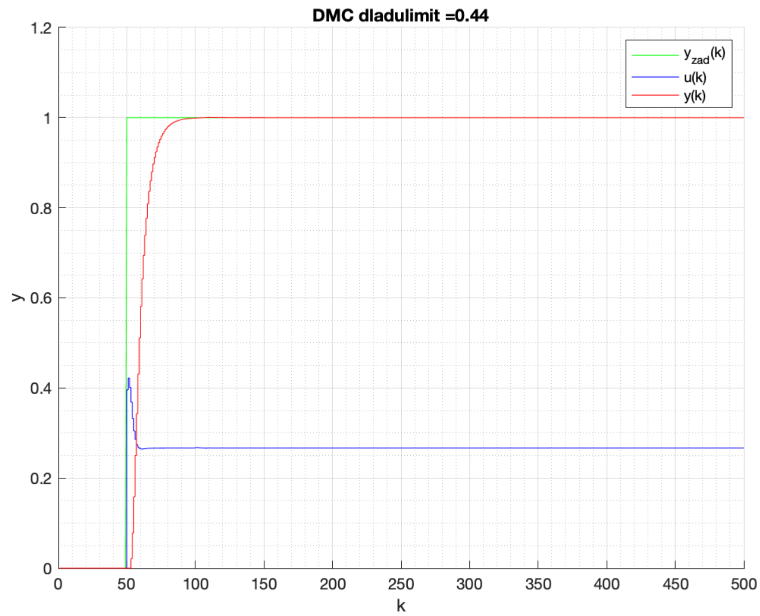
Ju
$\times 10^{-5}$
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Ju
0
10
20
30
40
50
60
70
80
90
100
N


Jy
×10^-7
Jy
Jy
N
0
10
20
30
40
50
60
70
80
90
100
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

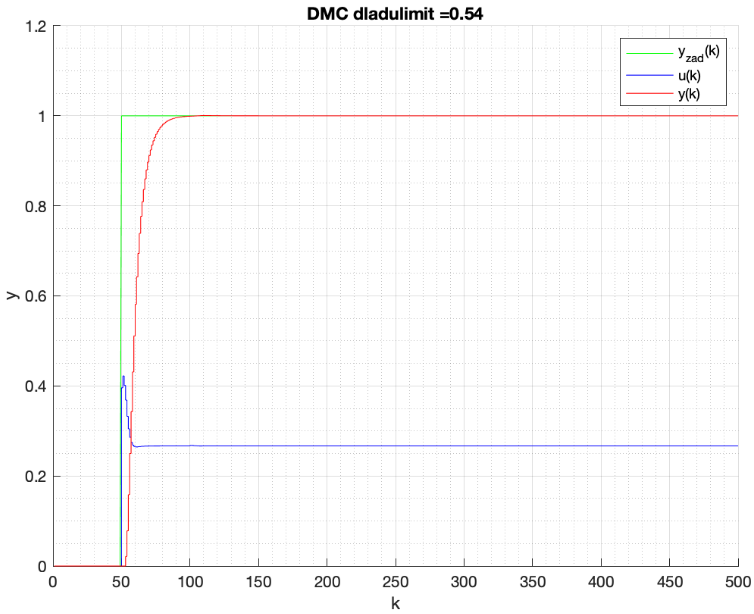

Ju
Ju
Ju
Nu
0
2
4
6
8
10
12
14
16
18
20
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

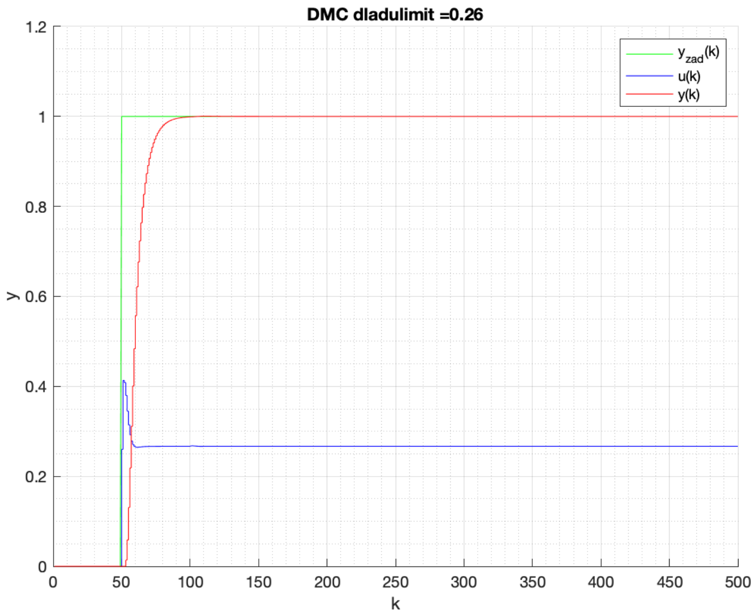


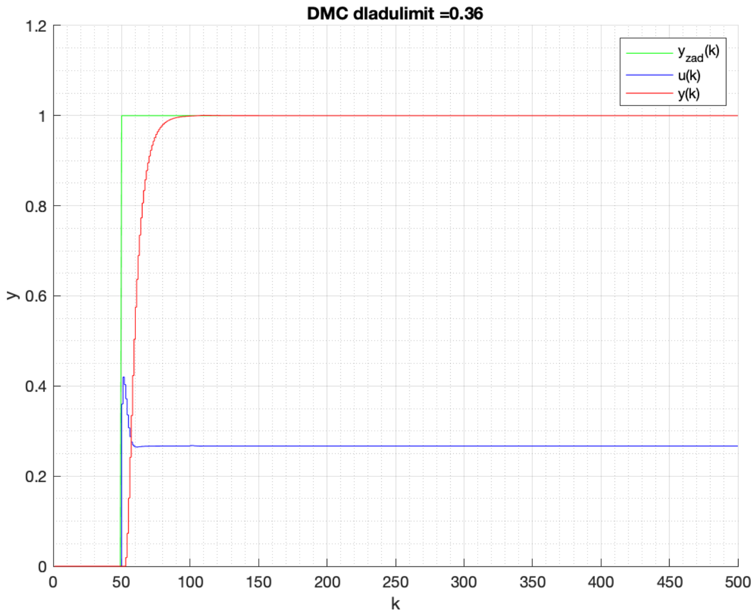
Jy
Jy
Jy
lambda

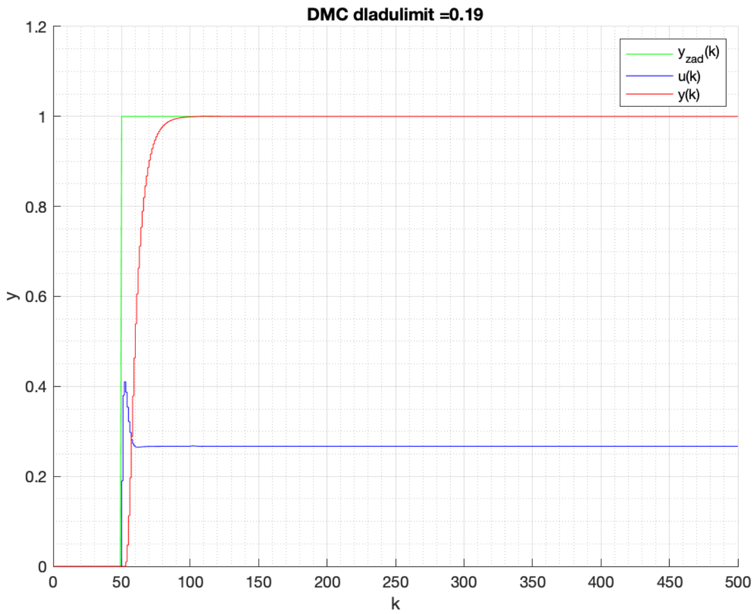


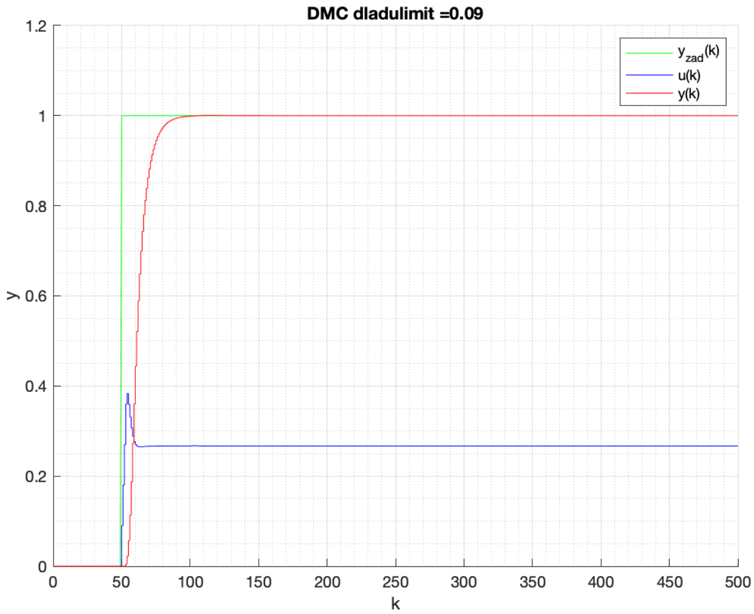
DMC dladulimit =0.44
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dladulimit =0.54
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

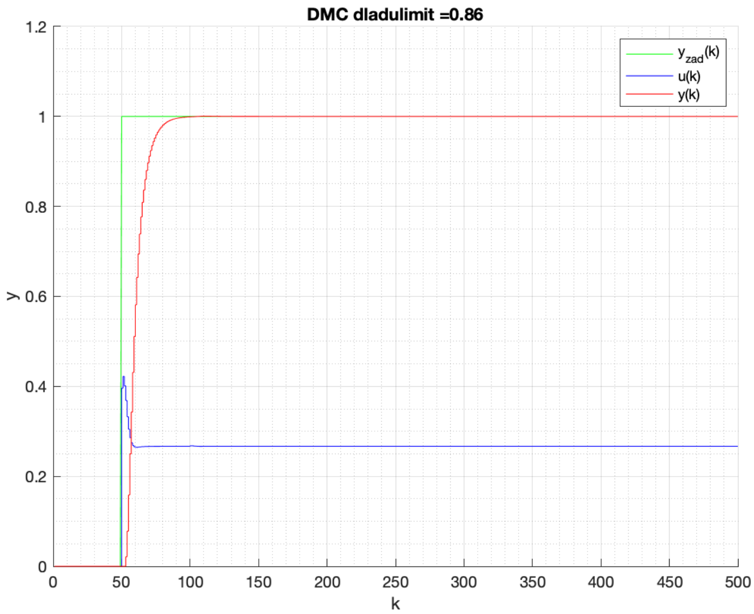

DMC dladulimit =0.26
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500


DMC dladulimit =0.36
y
k
$y_{zad}(k)$
u(k)
y(k)

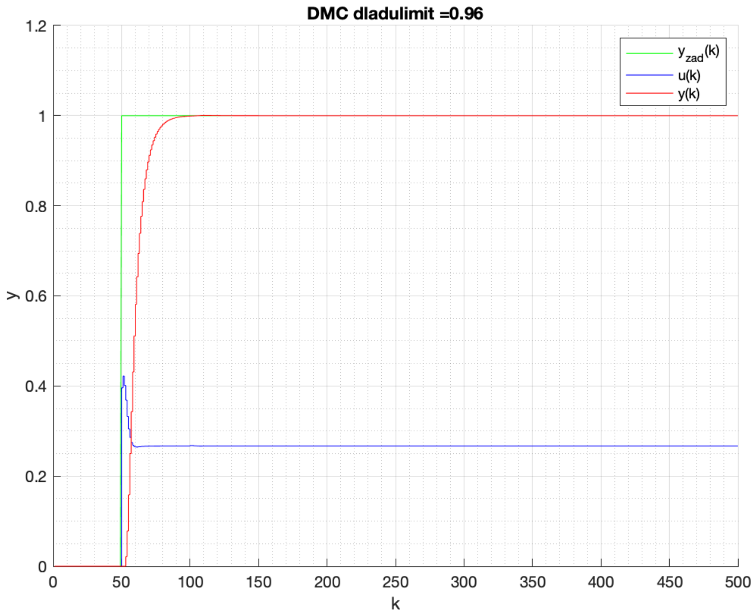

DMC dladulimit =0.19
y
k
$y_{zad}(k)$
u(k)
y(k)



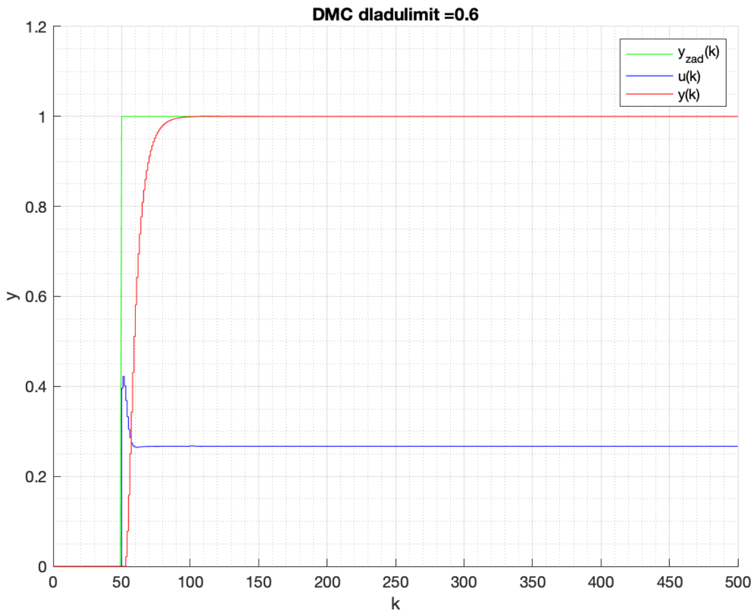
DMC dladulimit =0.09
$y_{zad}(k)$
u(k)
y(k)
y
k



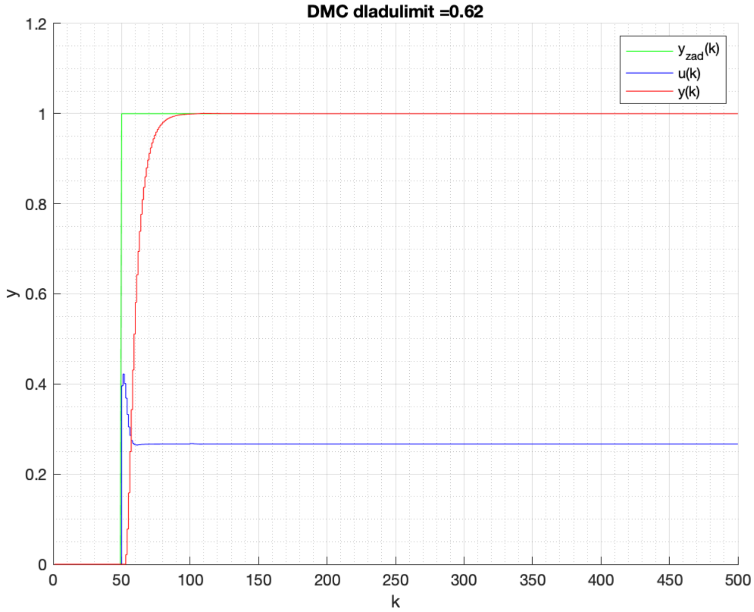
DMC dladulimit =0.86
$y_{zad}(k)$
u(k)
y(k)
y
k



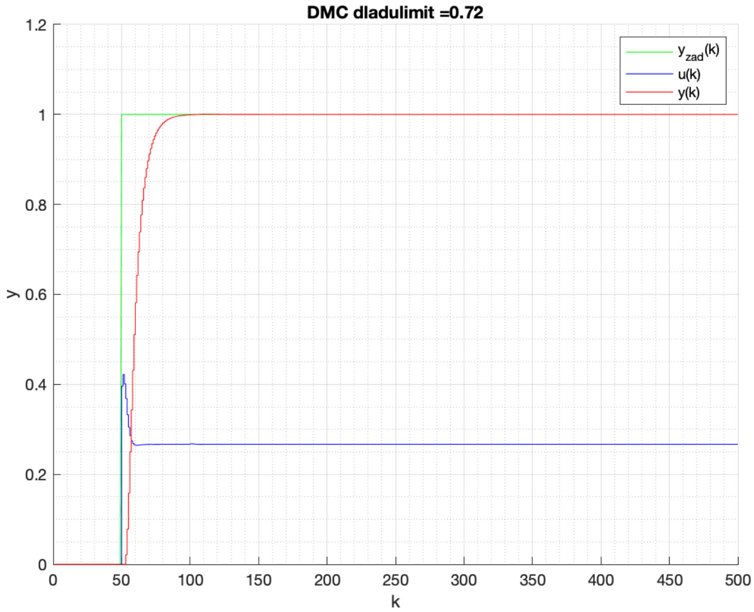
DMC dladulimit =0.96
$y_{zad}(k)$
u(k)
y(k)
y
k



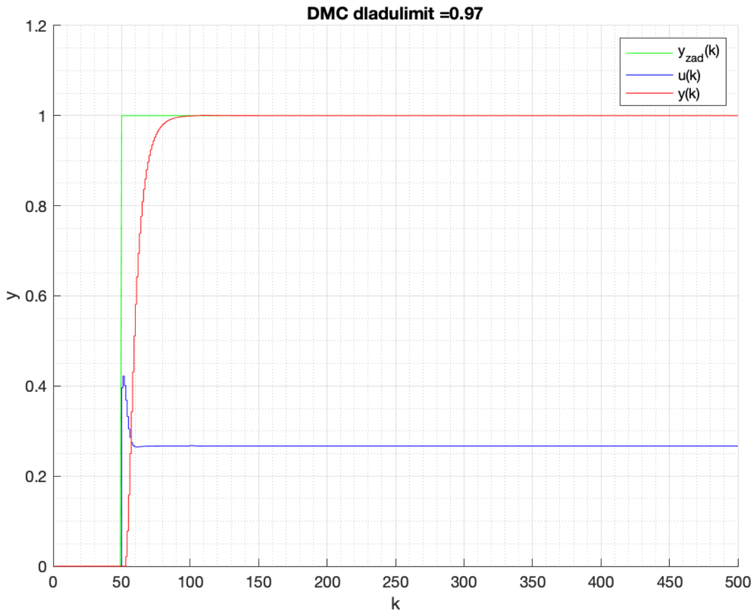
DMC dladulimit =0.6
$y_{zad}(k)$
u(k)
y(k)
y
k

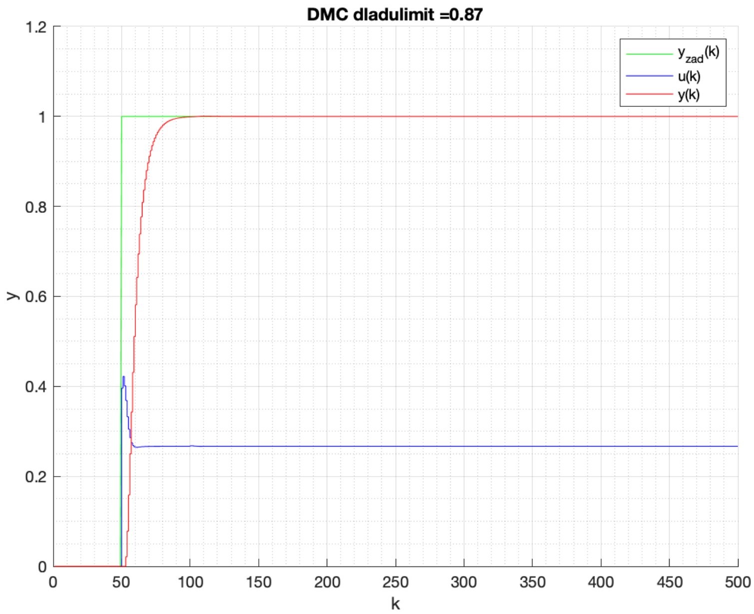


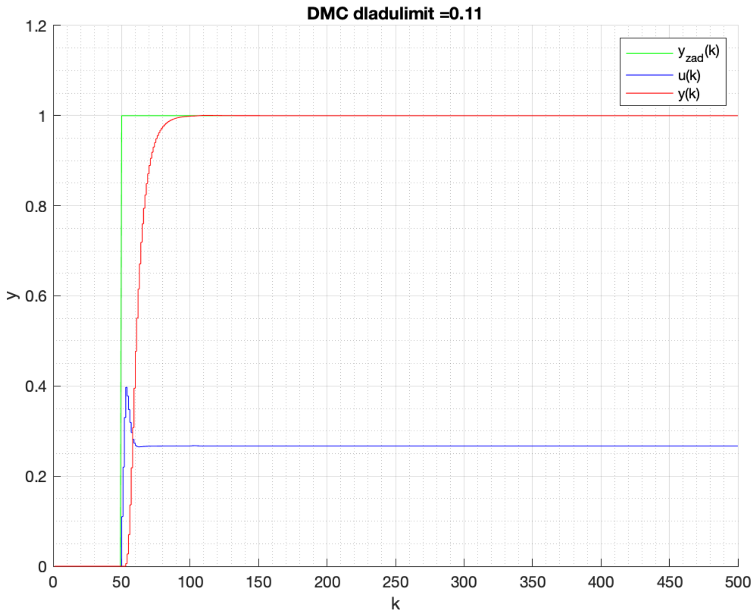
DMC dladulimit =0.62
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500



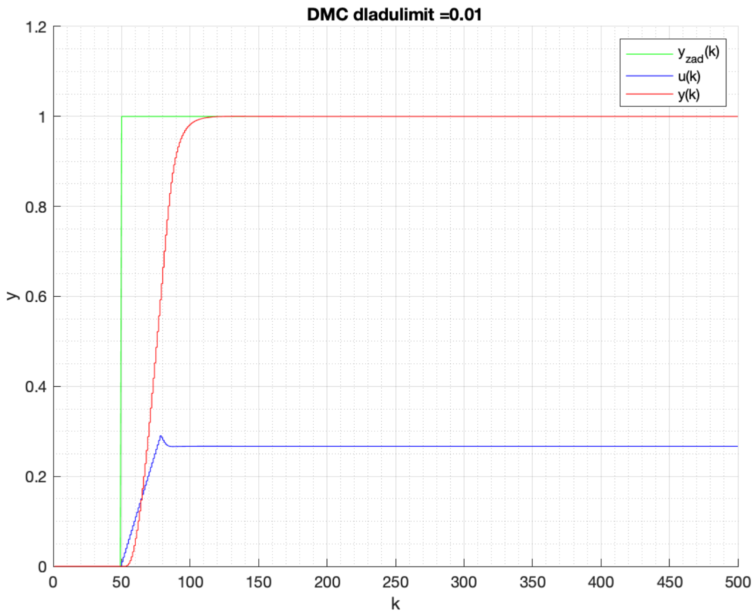
DMC dladulimit =0.72
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500


DMC dladulimit =0.97
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

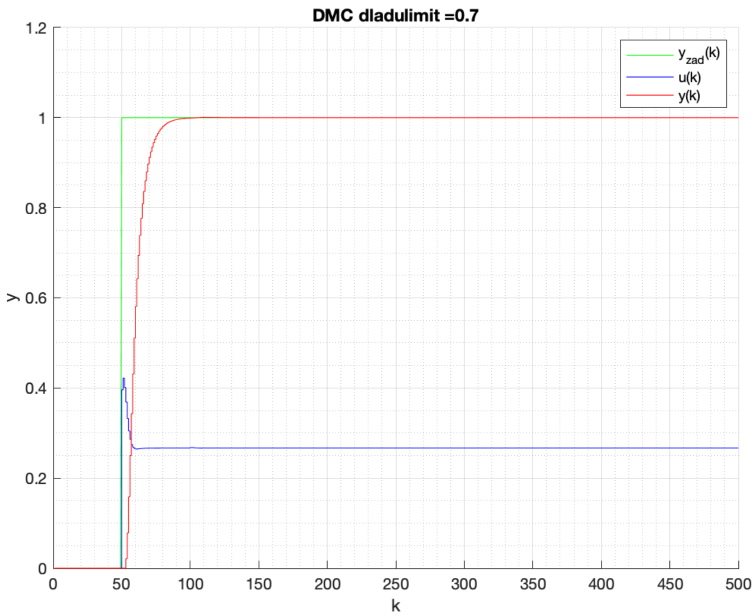

DMC dladulimit =0.87
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

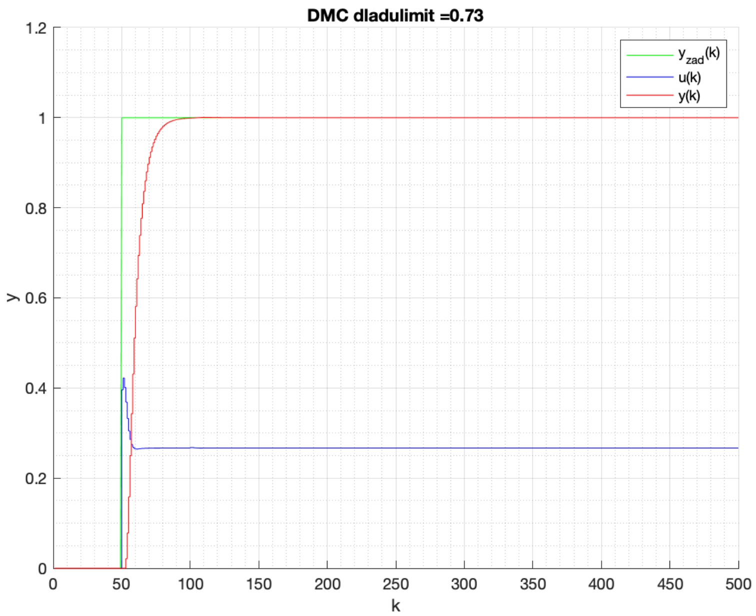


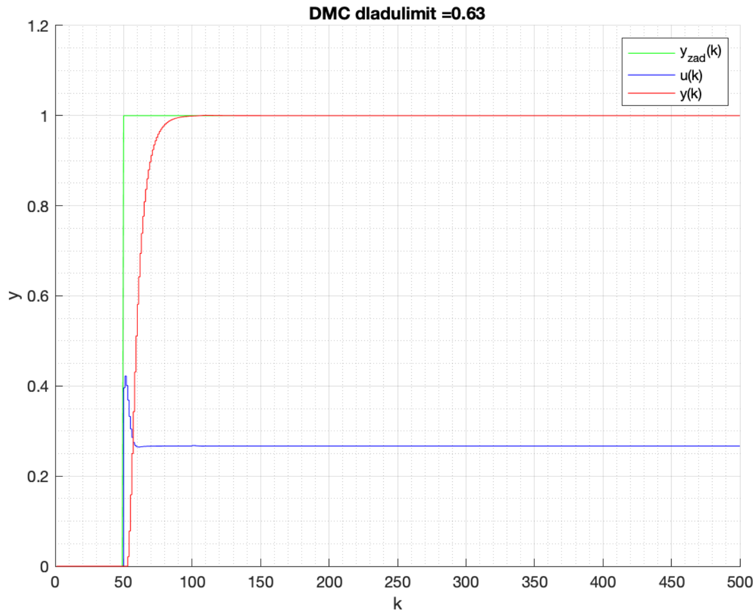
DMC dladulimit =0.11
$y_{zad}(k)$
u(k)
y(k)
y
k



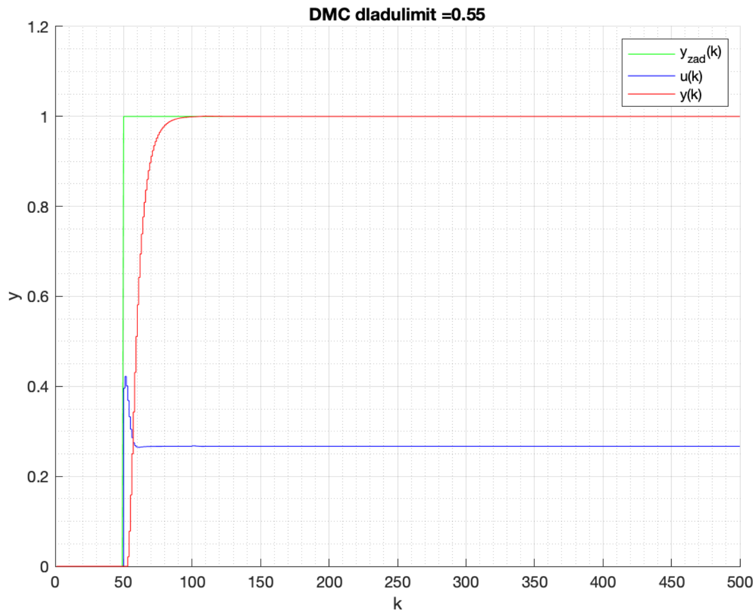
DMC dladulimit =0.01
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dladulimit =0.7
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

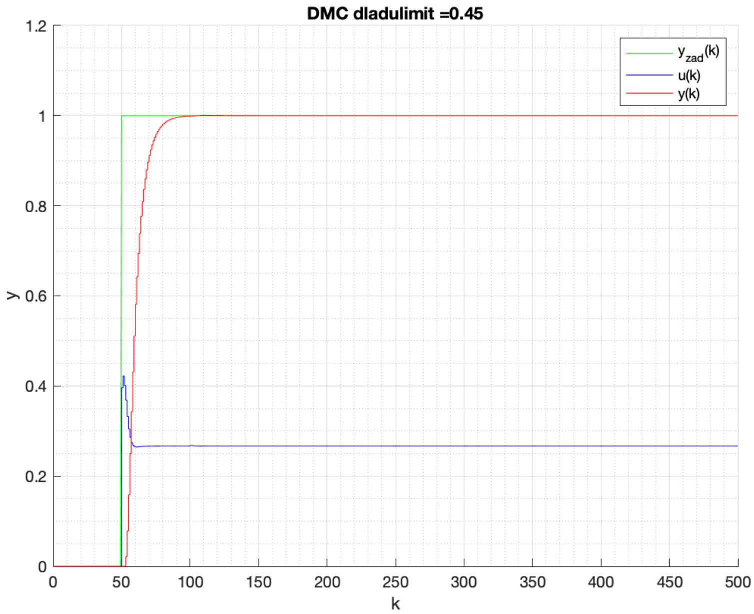

DMC dladulimit =0.73
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

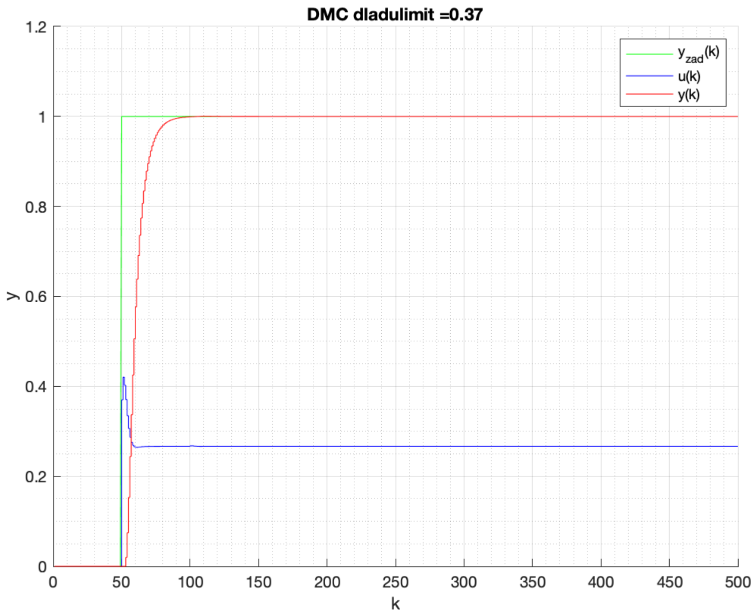


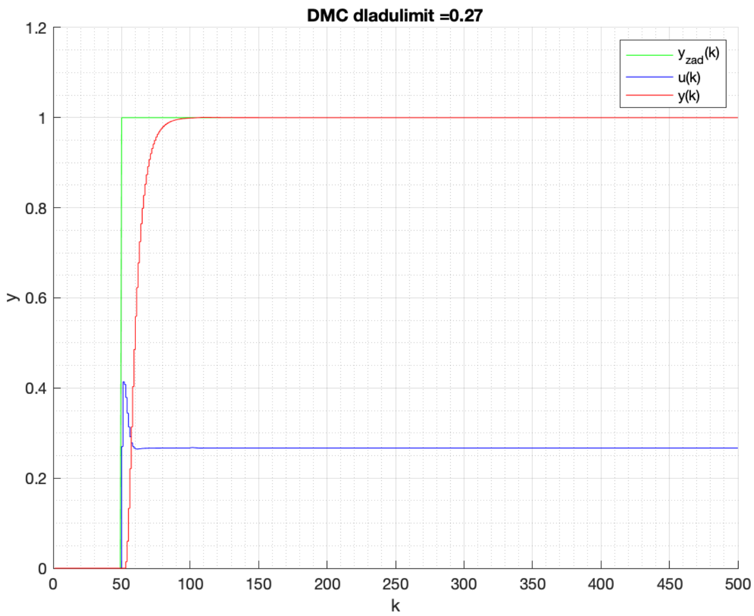
DMC dladulimit =0.63
y
k
$y_{zad}(k)$
u(k)
y(k)

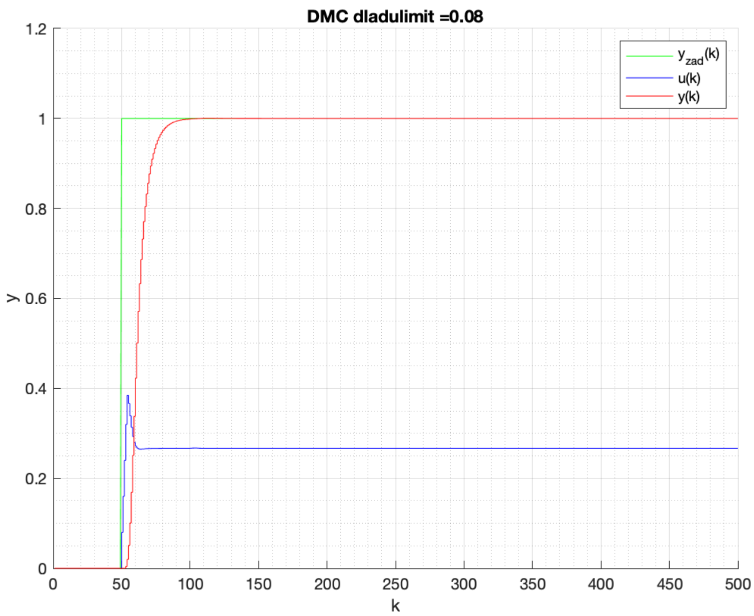


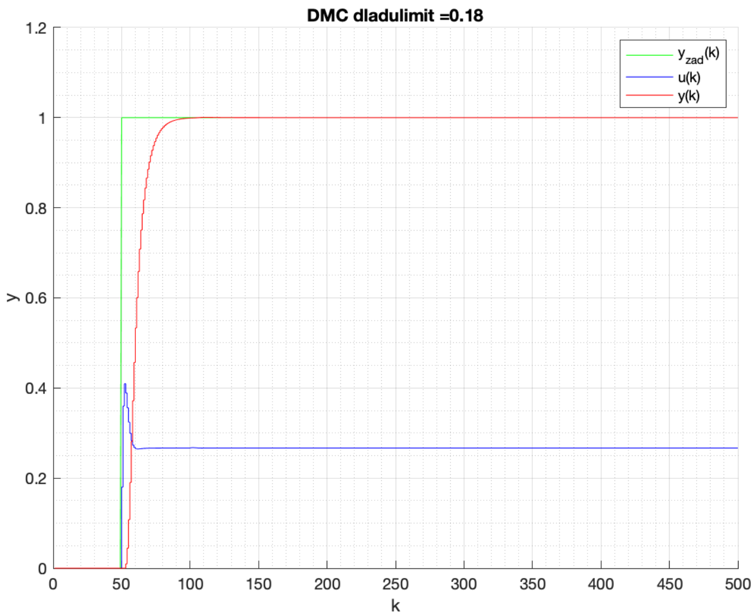
DMC dladulimit =0.55
y
k
$y_{zad}(k)$
u(k)
y(k)

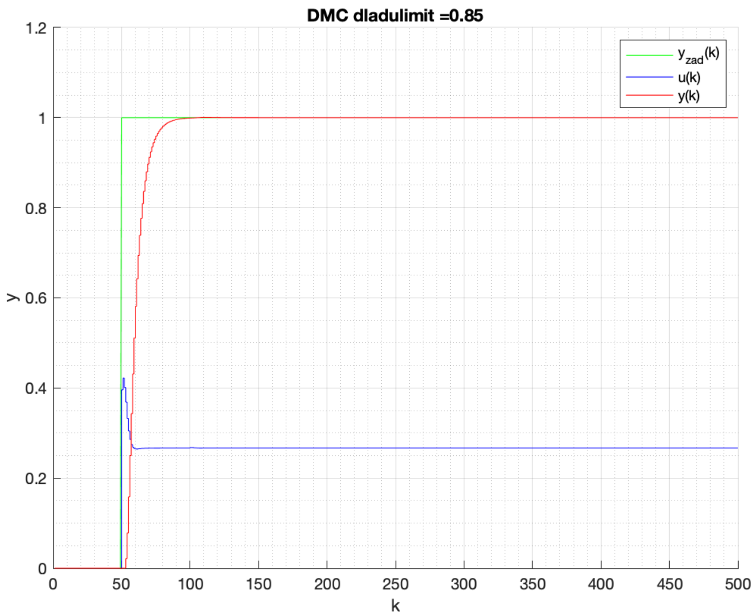

DMC dladulimit =0.45
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

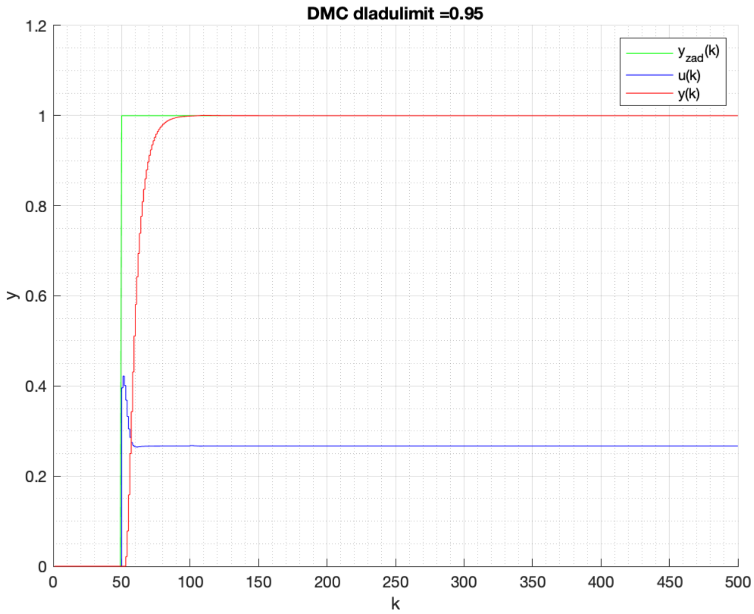

DMC dladulimit =0.37
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

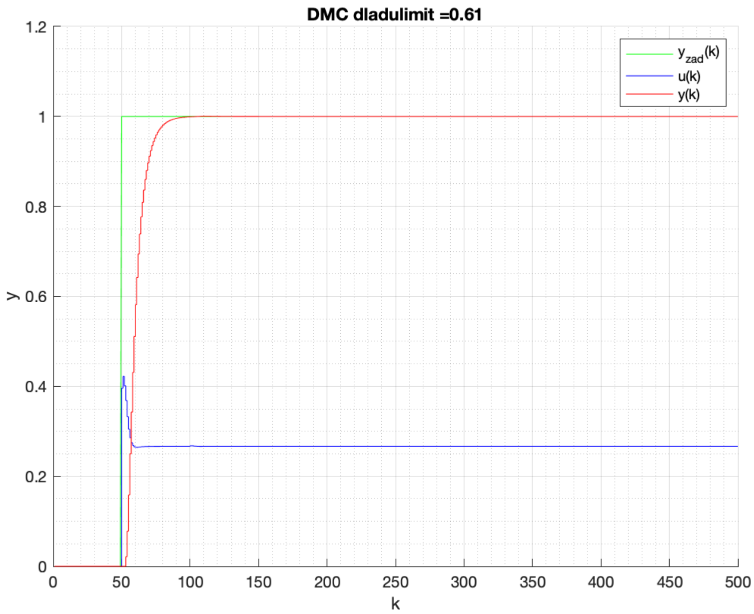

DMC dladulimit =0.27
y
k
$y_{zad}(k)$
u(k)
y(k)

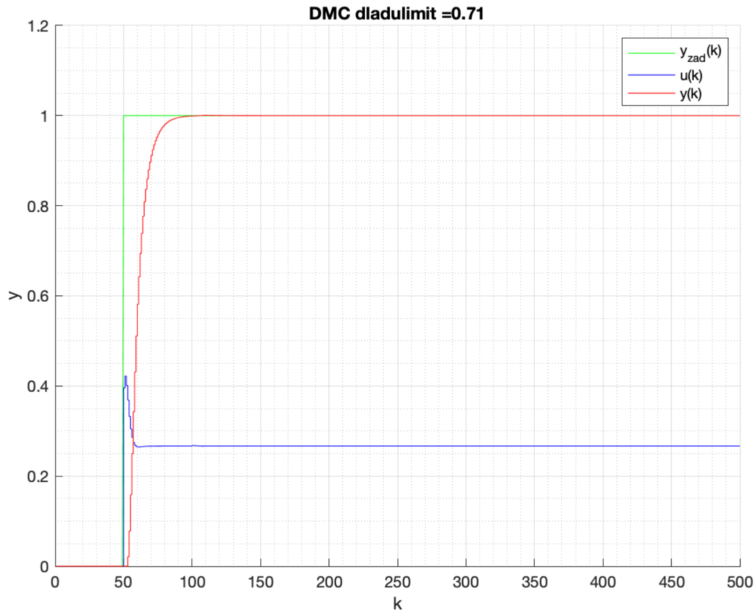

DMC dladulimit =0.08
y
k
$y_{zad}(k)$
u(k)
y(k)

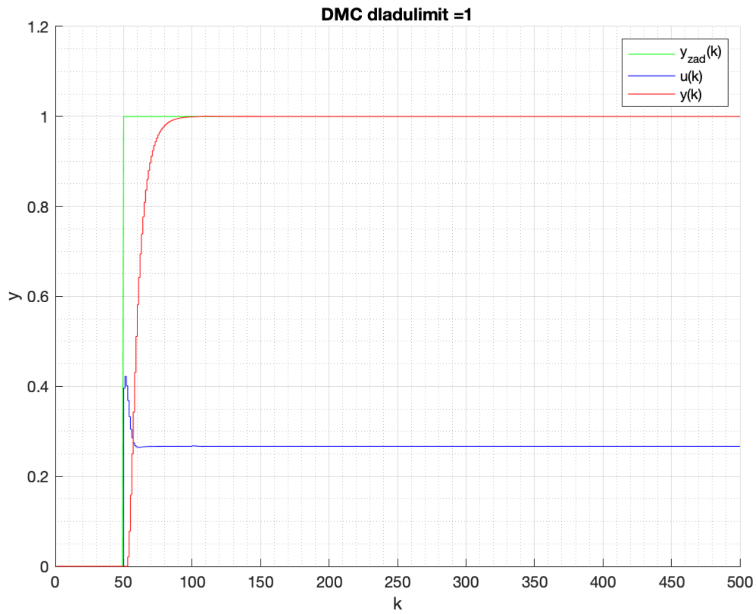

DMC dladulimit =0.18
y
k
yzad(k)
u(k)
y(k)

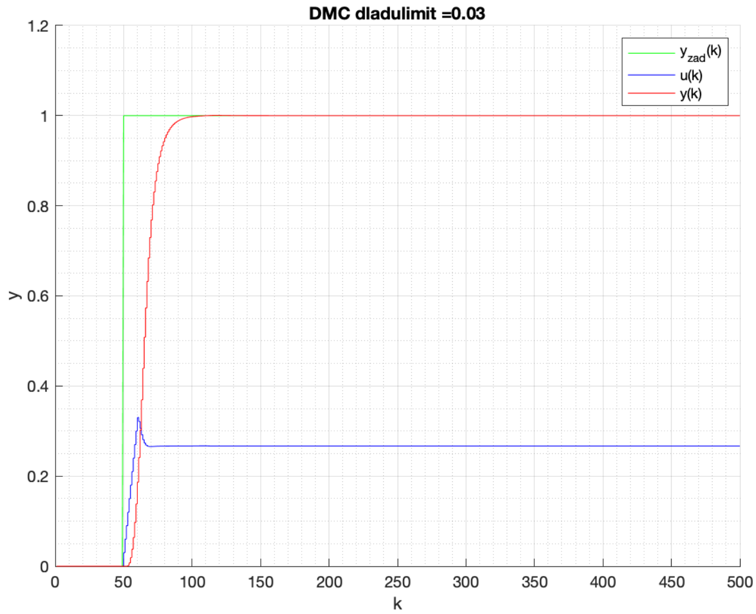

DMC dladulimit =0.85
y
k
yzad(k)
u(k)
y(k)

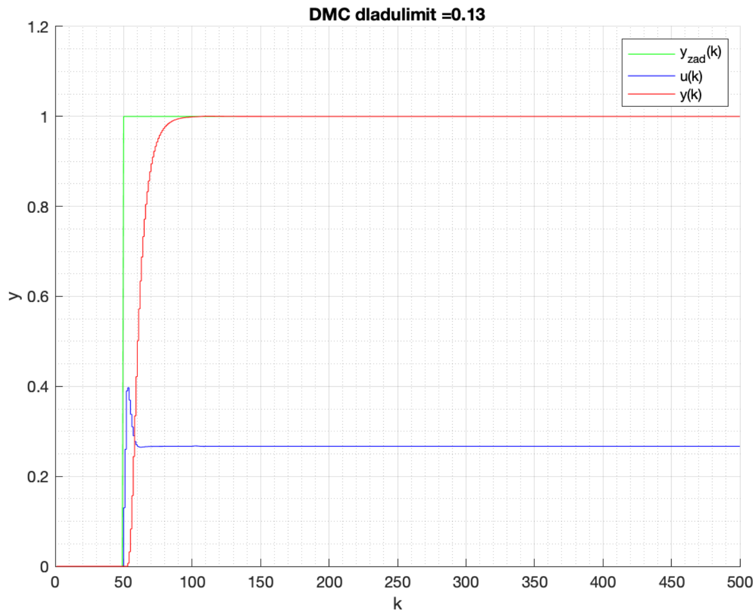

DMC dladulimit =0.95
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

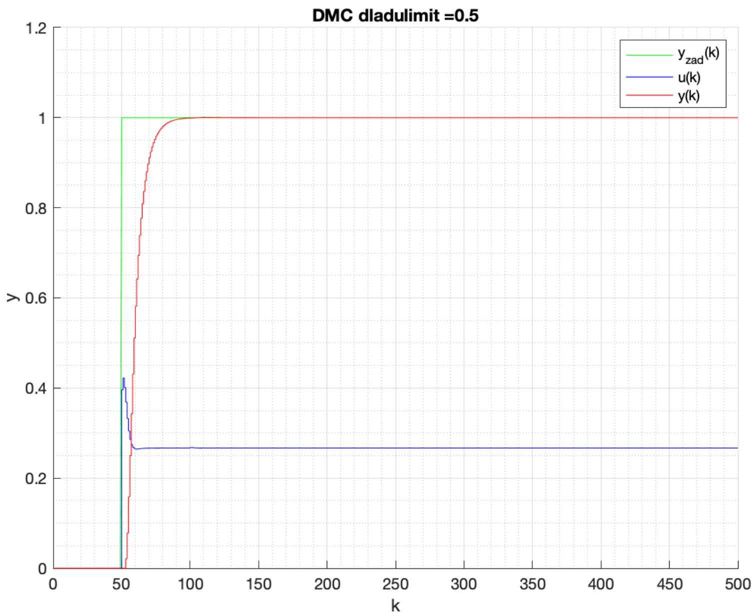

DMC dladulimit =0.61
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

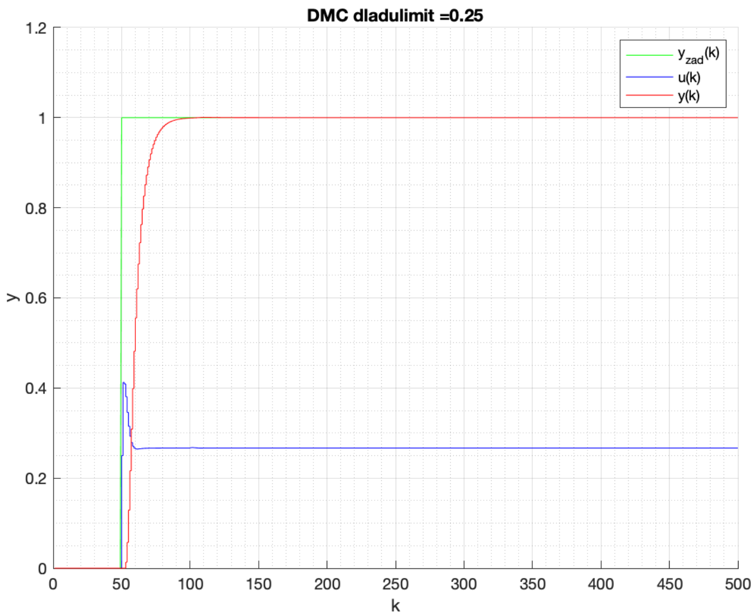

DMC dladulimit =0.71
y
k
$y_{zad}(k)$
u(k)
y(k)

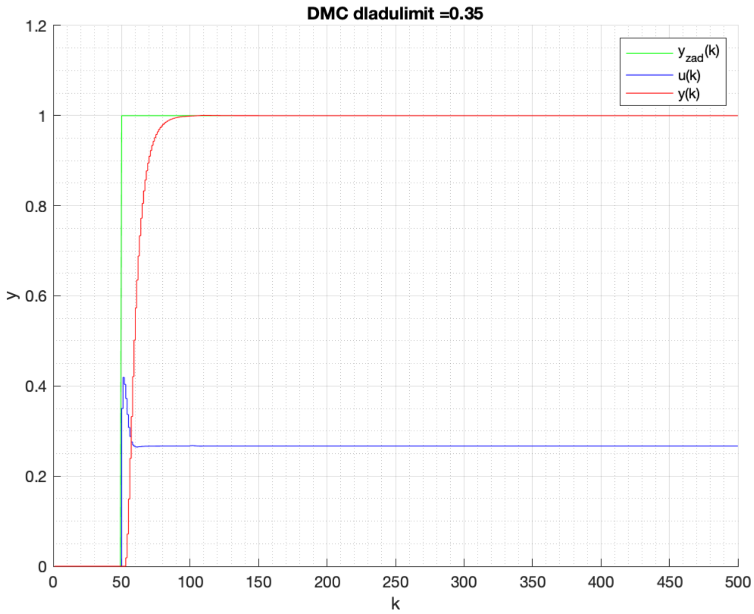

DMC dladulimit =1
y
k
$y_{zad}(k)$
u(k)
y(k)

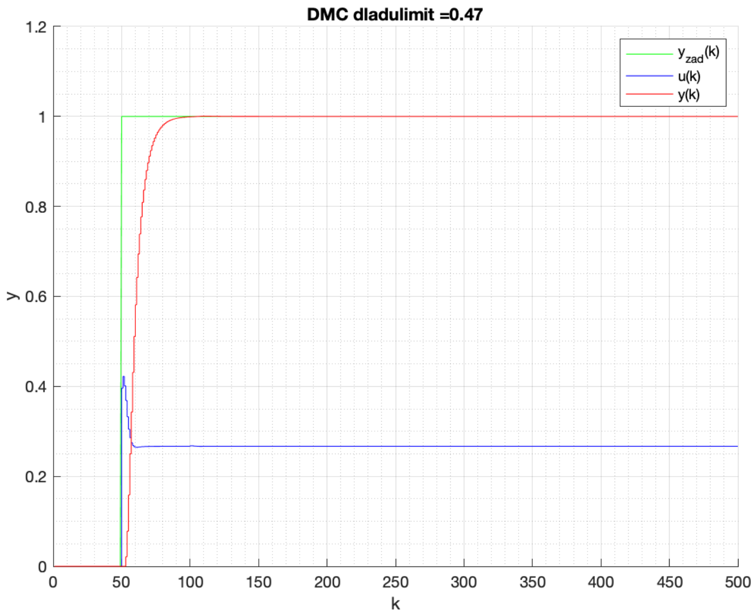

DMC dladulimit =0.03
1.2
1
0.8
y 0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500
k
$y_{zad}(k)$
u(k)
y(k)

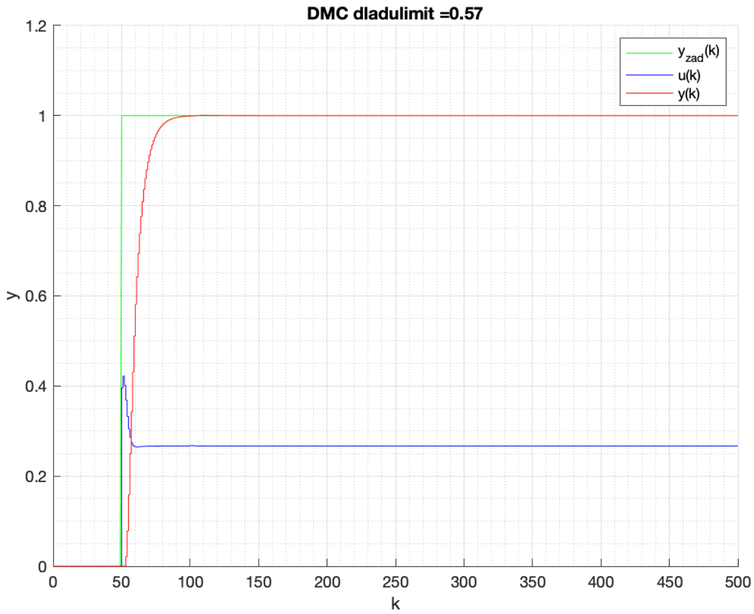

DMC dladulimit =0.13
1.2
1
0.8
y 0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500
k
$y_{zad}(k)$
u(k)
y(k)

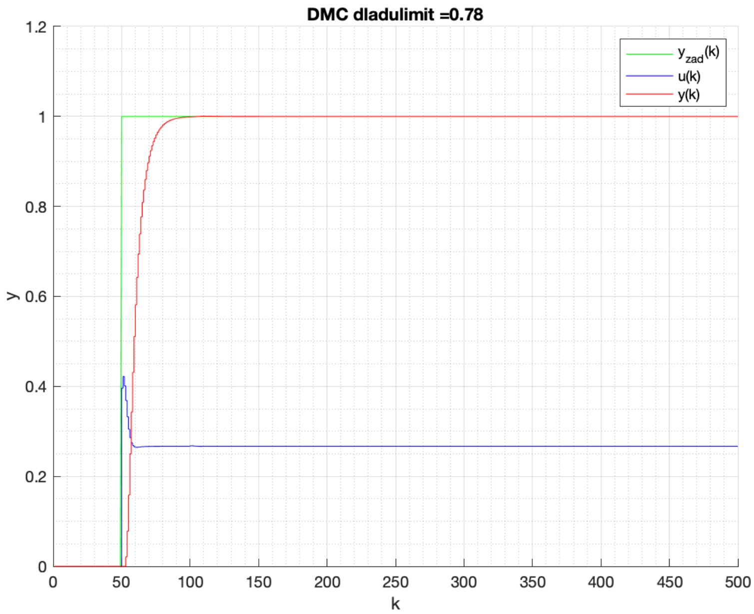

DMC dladulimit =0.5
y
k
$y_{zad}(k)$
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

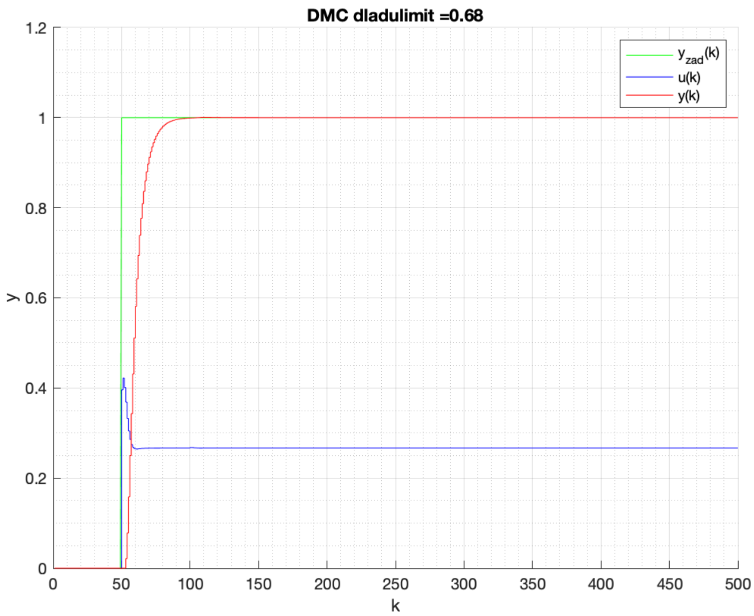

DMC dladulimit =0.25
y
k
$y_{zad}(k)$
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

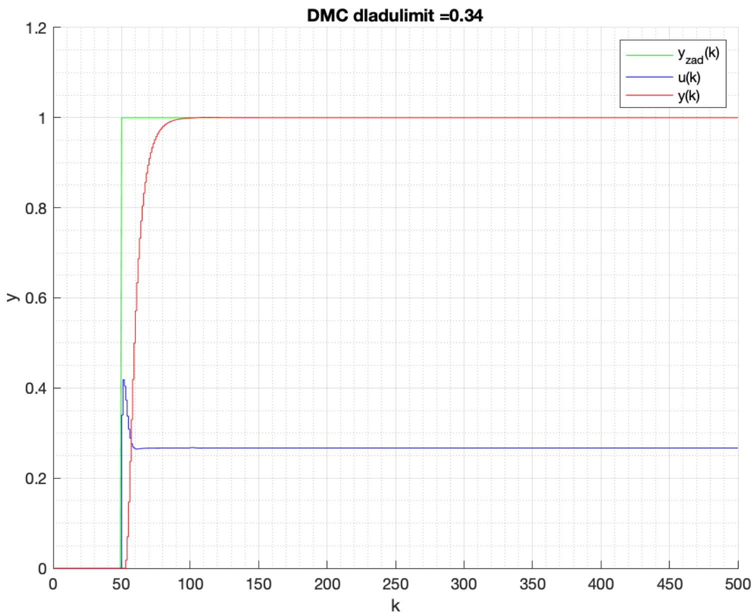

DMC dladulimit =0.35
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

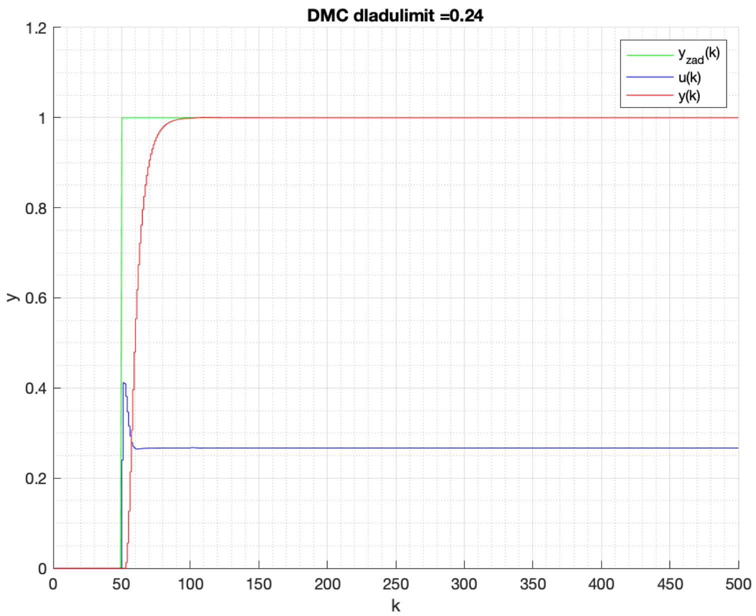

DMC dladulimit =0.47
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

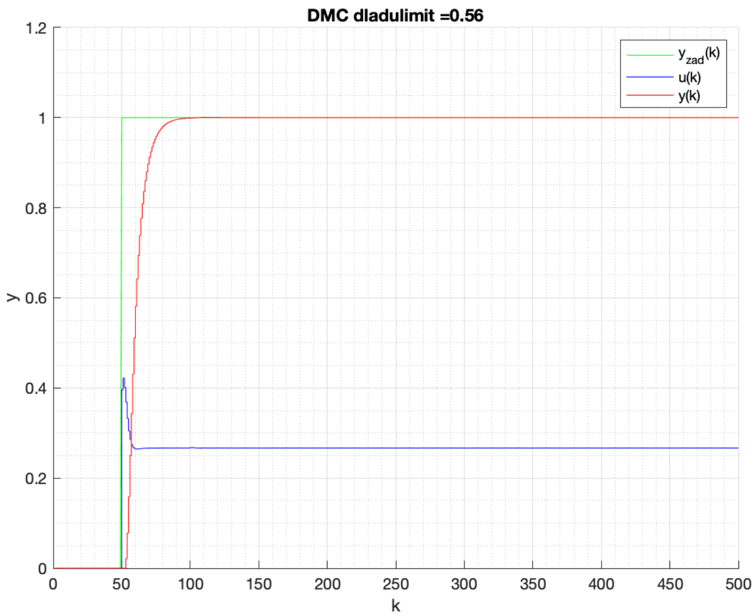

DMC dladulimit =0.57
1.2
1
0.8
y 0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500
k
y_zad(k)
u(k)
y(k)

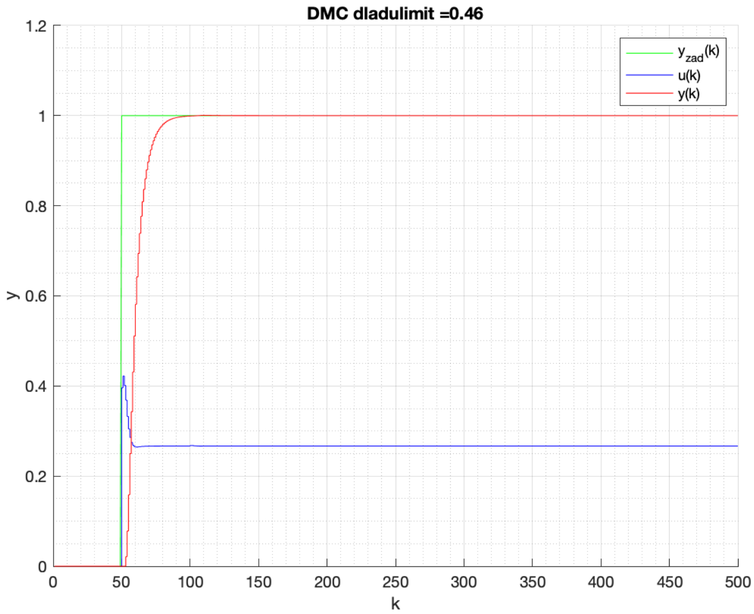

DMC dladulimit =0.78
1.2
1
0.8
y 0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500
k
y_zad(k)
u(k)
y(k)

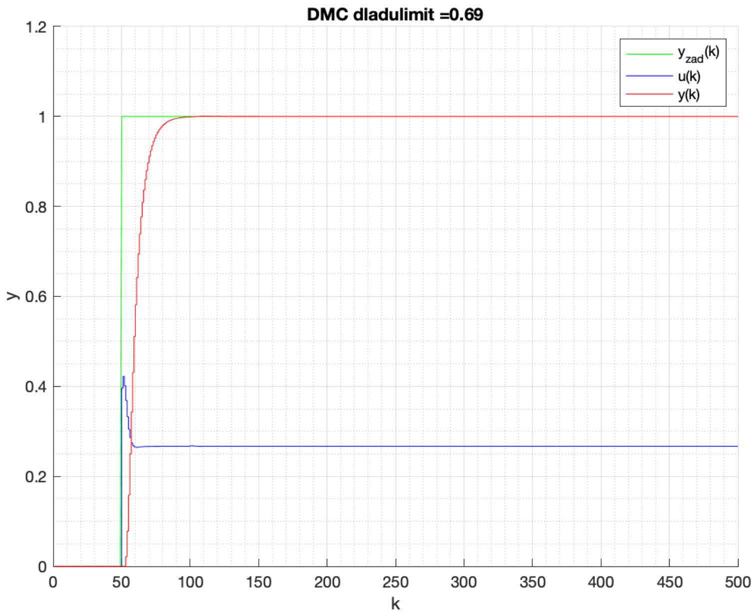

DMC dladulimit =0.68
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

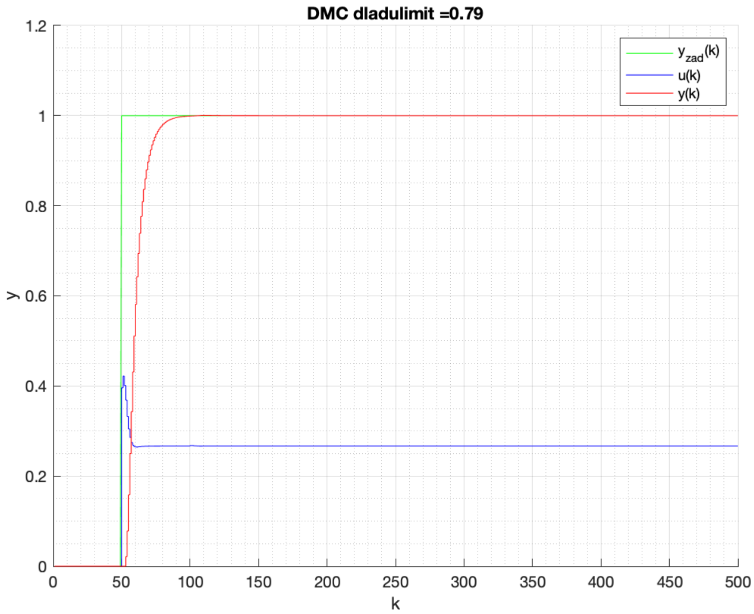

DMC dladulimit =0.34
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

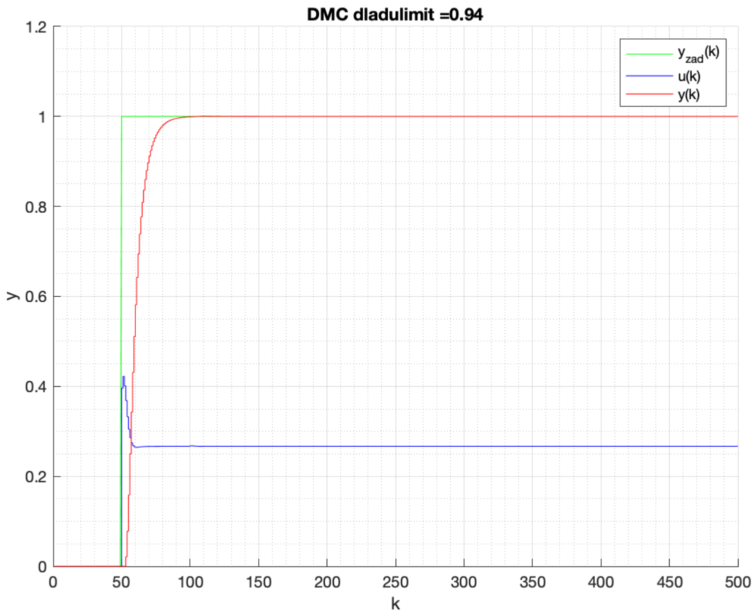

DMC dladulimit =0.24
$y_{zad}(k)$
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

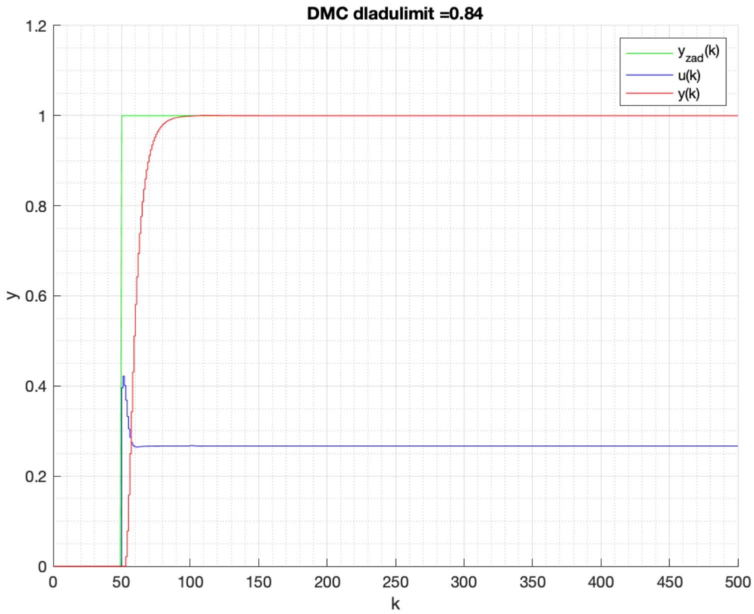

DMC dladulimit =0.56
$y_{zad}(k)$
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

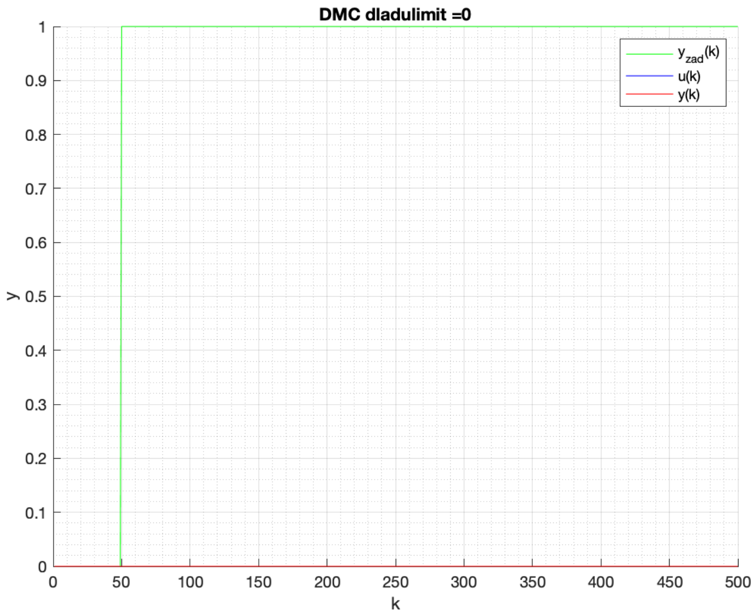

DMC dladulimit =0.46
y
k
yzad(k)
u(k)
y(k)

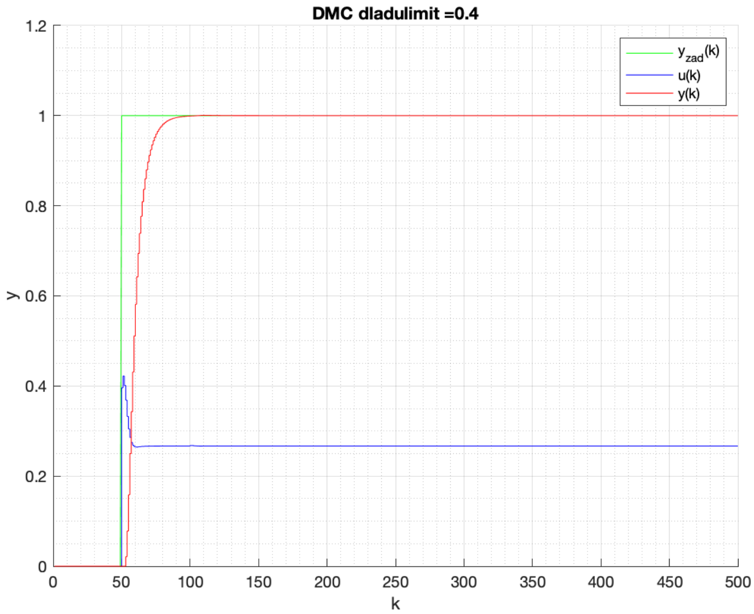

DMC dladulimit =0.69
y
k
yzad(k)
u(k)
y(k)

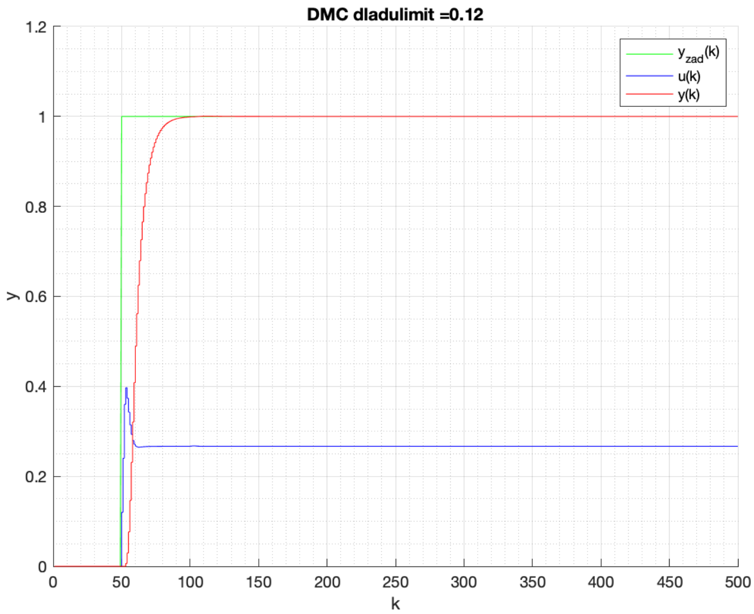

DMC dladulimit =0.79
$y_{zad}(k)$
u(k)
y(k)
y
k

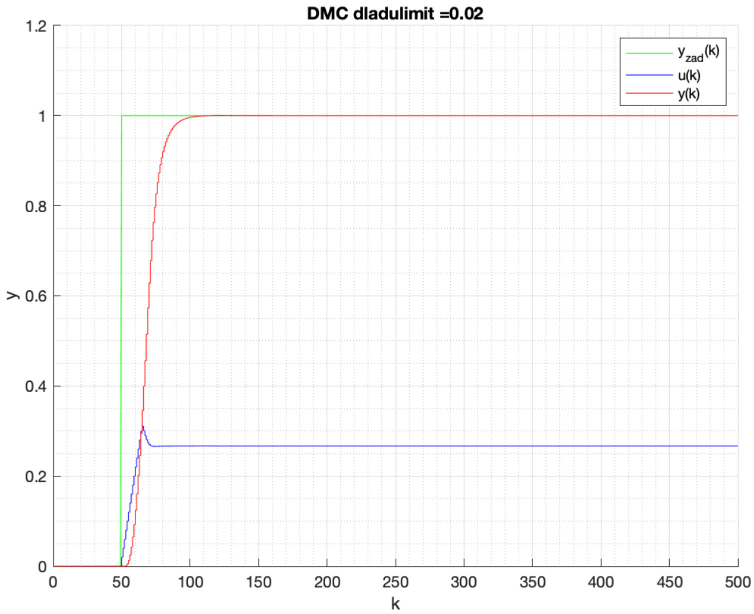

DMC dladulimit =0.94
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dladulimit =0.84
$y_{zad}(k)$
u(k)
y(k)
y
k

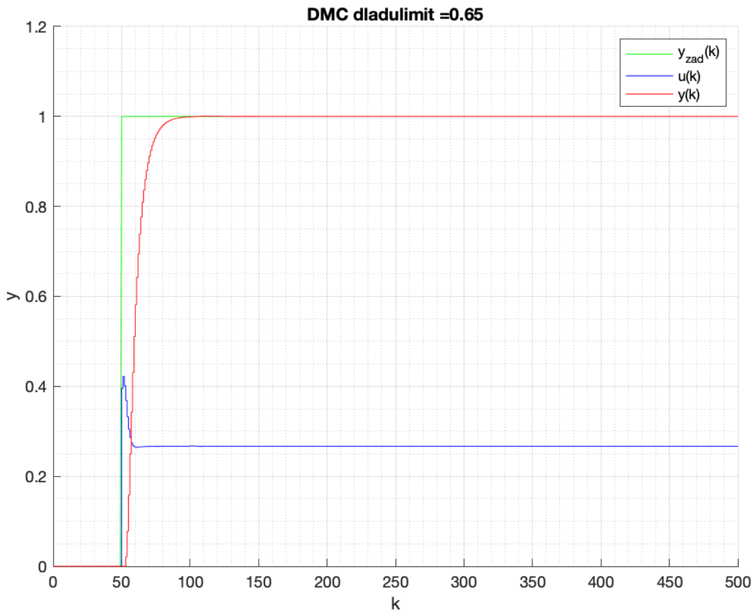

DMC dladulimit =0
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dladulimit =0.4
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

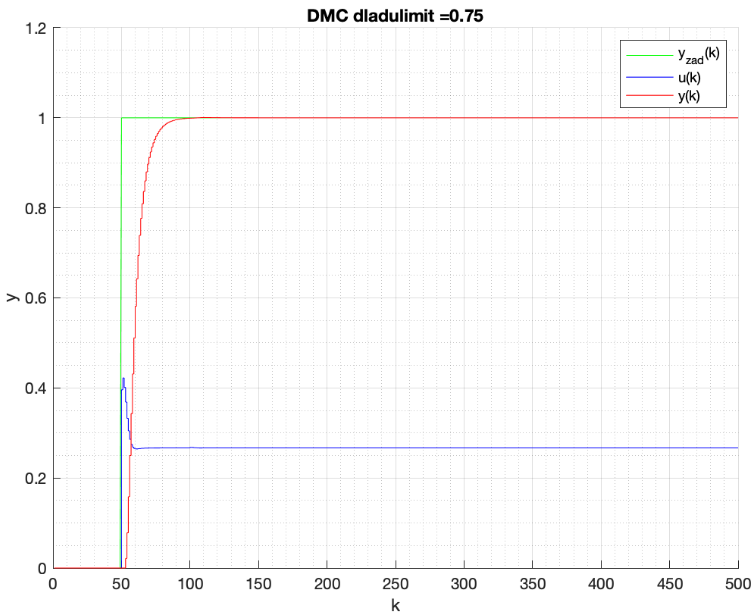

DMC dladulimit =0.12
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

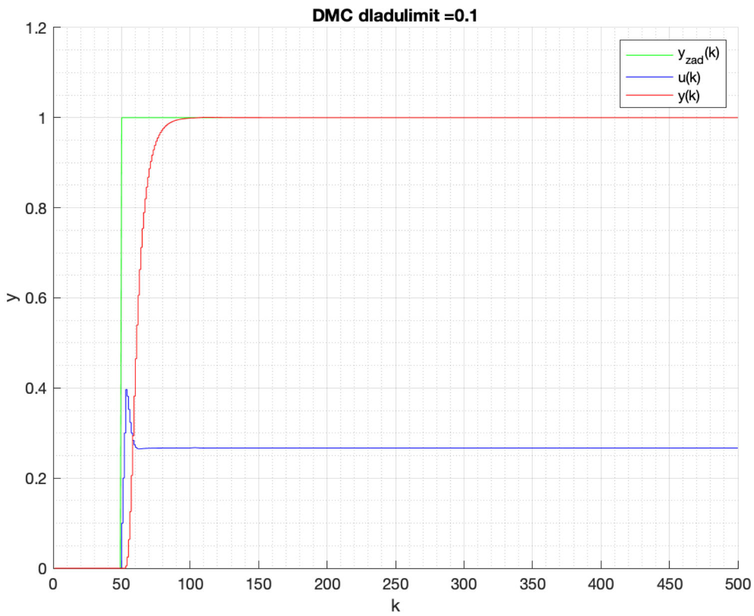


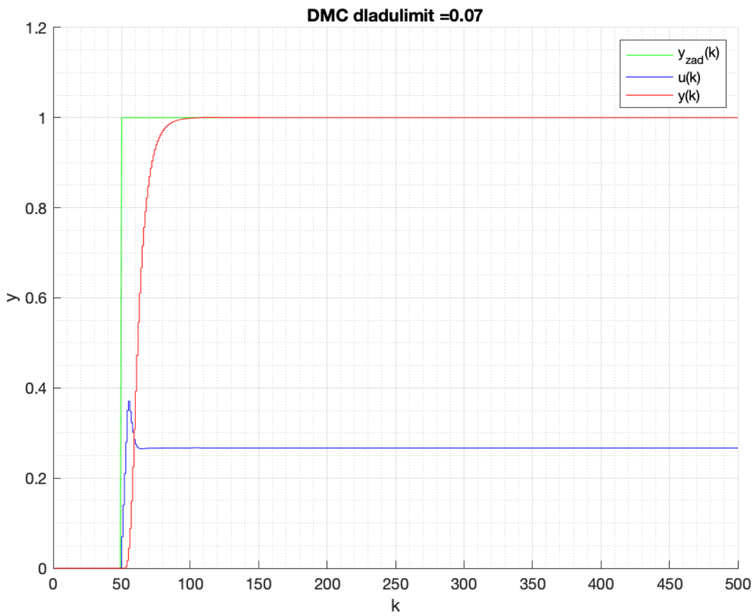
DMC dladulimit =0.02
y
k
$y_{zad}(k)$
u(k)
y(k)

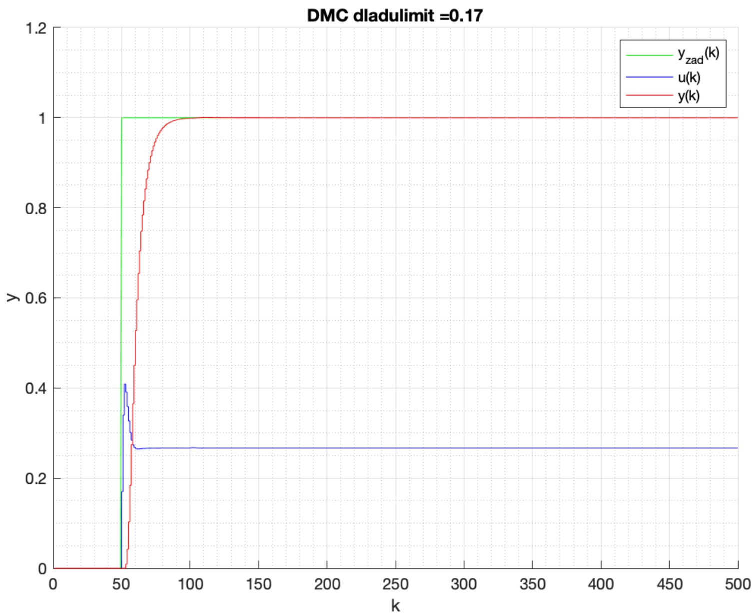


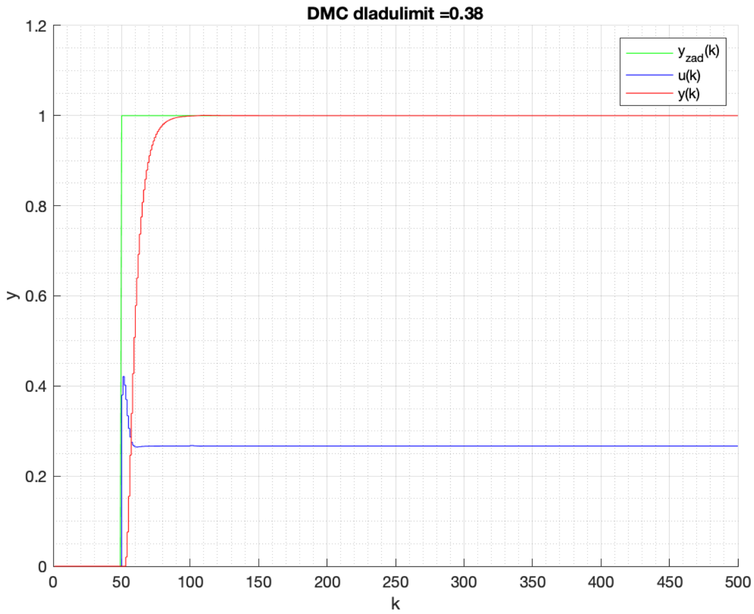
DMC dladulimit =0.65
y
k
$y_{zad}(k)$
u(k)
y(k)

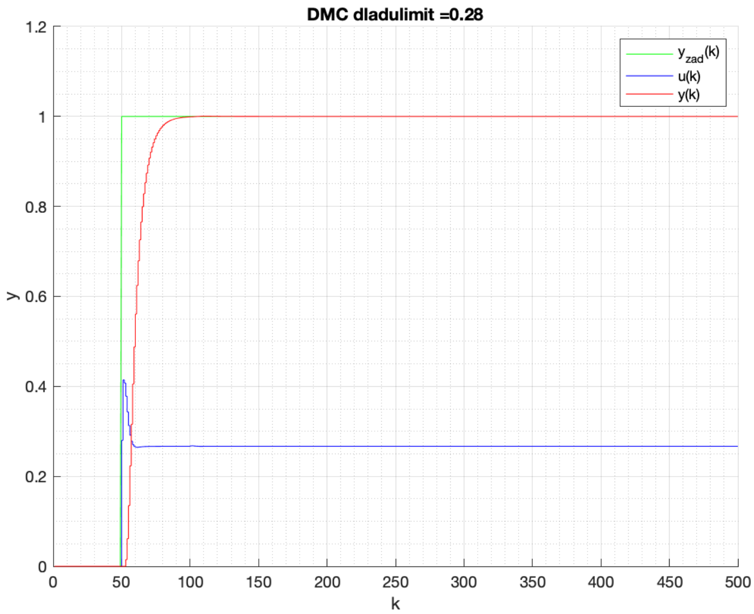

DMC dladulimit =0.75
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

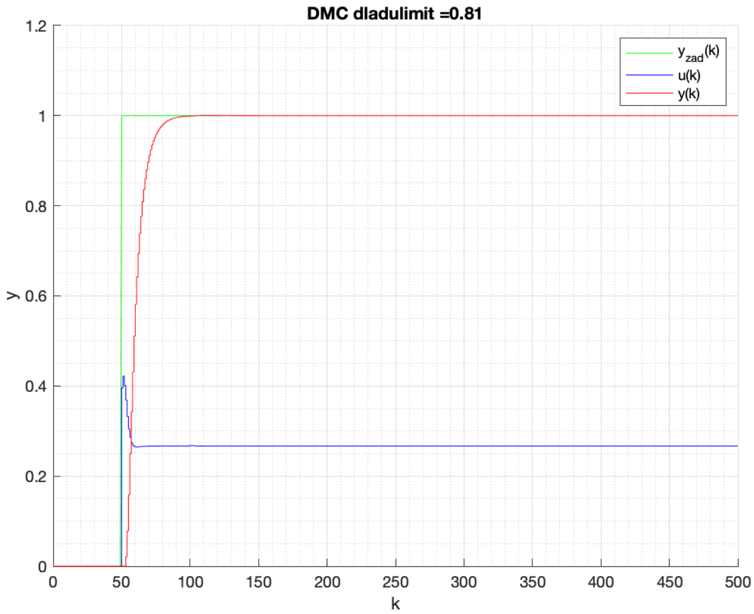

DMC dladulimit =0.1
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

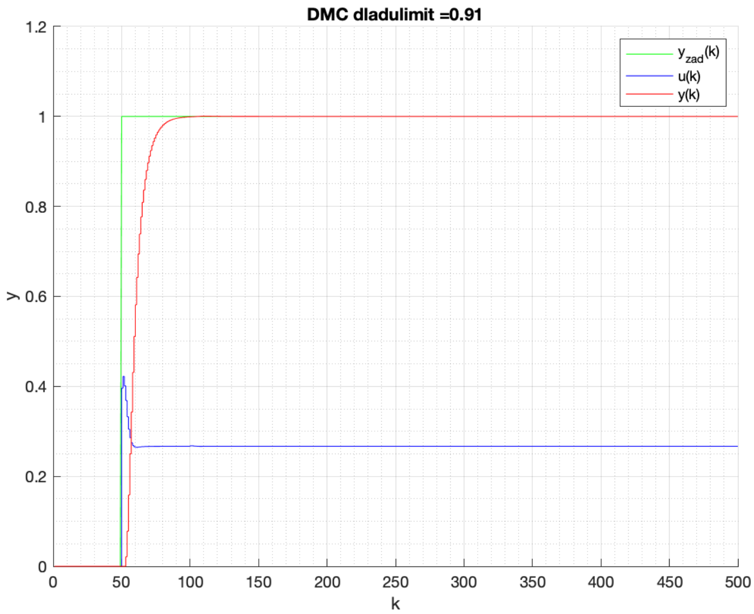

DMC dladulimit =0.07
$y_{zad}(k)$
u(k)
y(k)
y
k

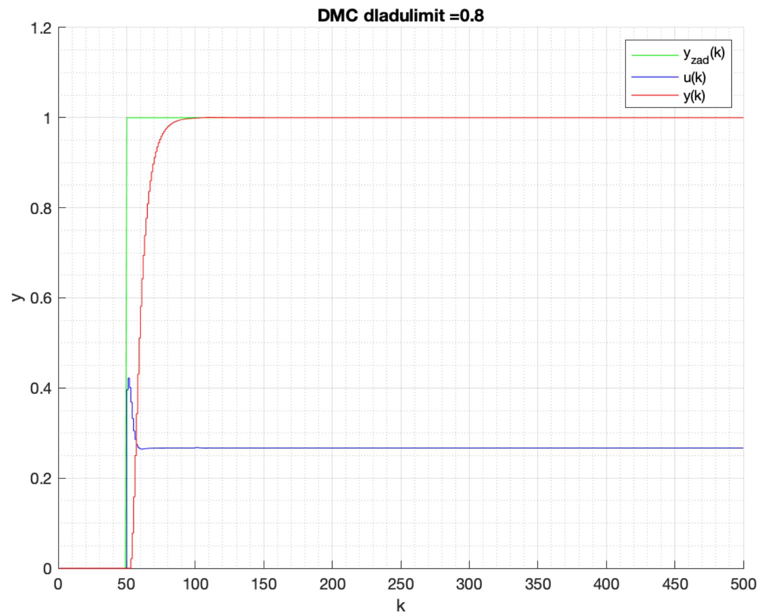

DMC dladulimit =0.17
$y_{zad}(k)$
u(k)
y(k)
y
k

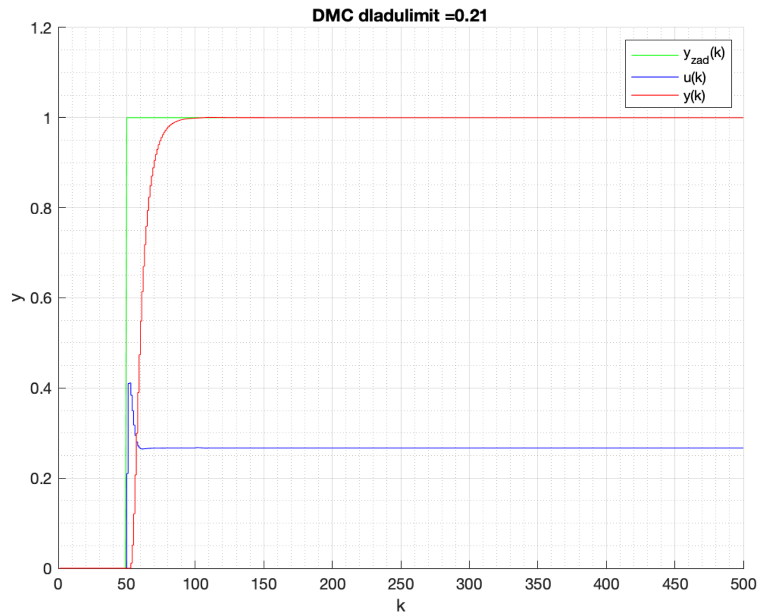

DMC dladulimit =0.38
$y_{zad}(k)$
u(k)
y(k)
y
k

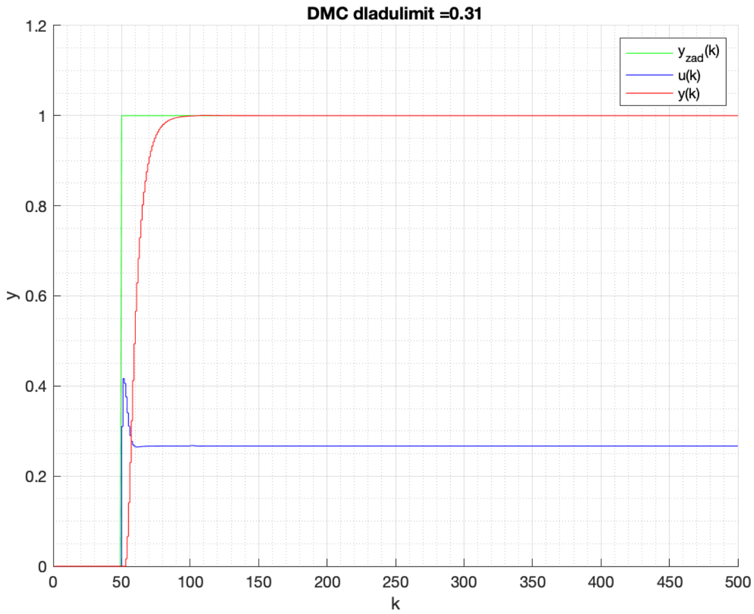

DMC dladulimit =0.28
$y_{zad}(k)$
u(k)
y(k)
y
k

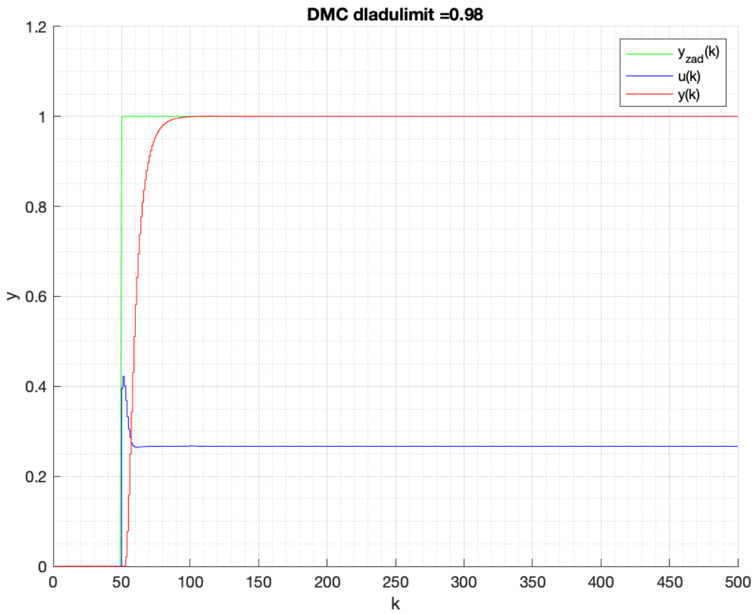

DMC dladulimit =0.81
y
k
y_zad(k)
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

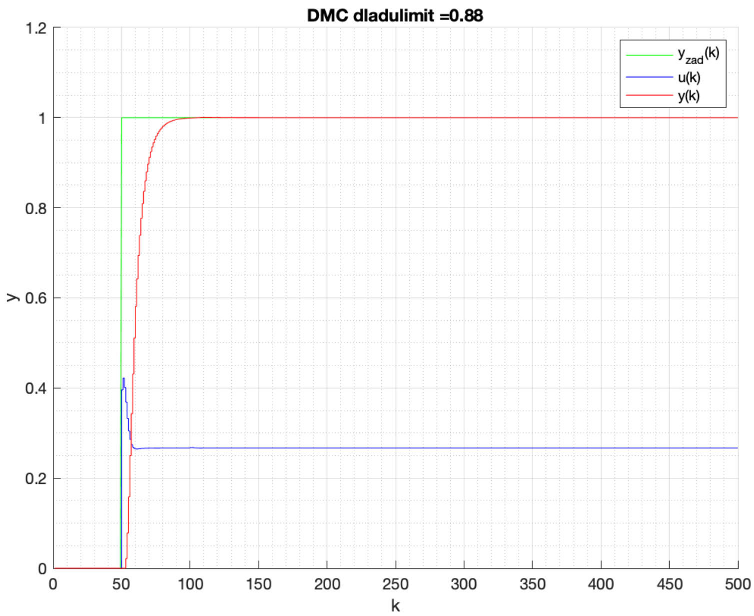

DMC dladulimit =0.91
y
k
y_zad(k)
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

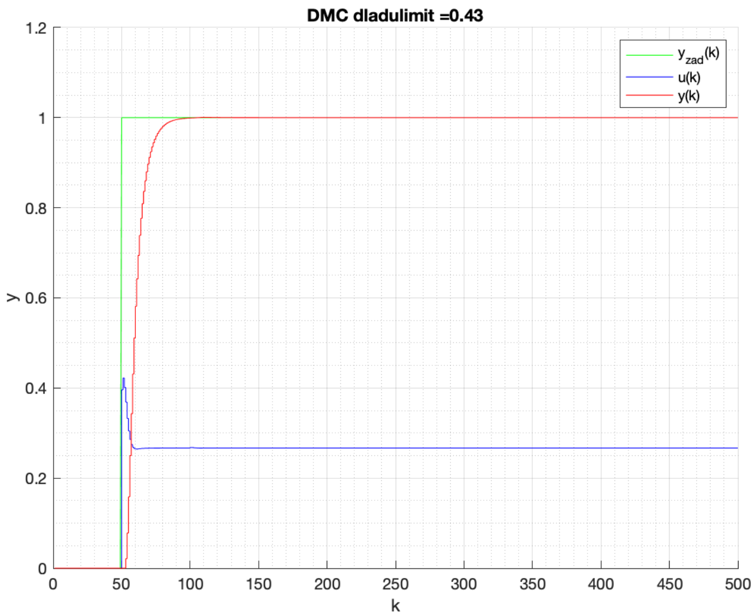

DMC dladulimit =0.8
$y_{zad}(k)$
u(k)
y(k)
y
k

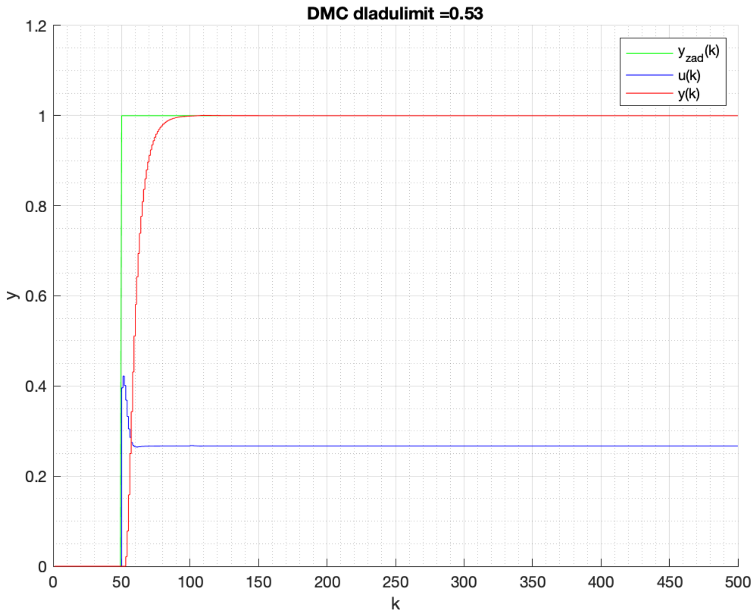

DMC dladulimit =0.21
$y_{zad}(k)$
u(k)
y(k)
y
k

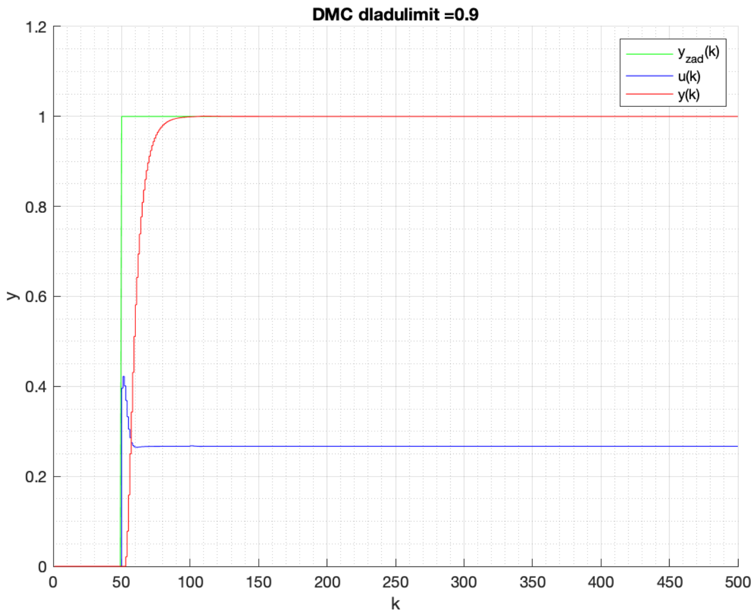

DMC dladulimit =0.31
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

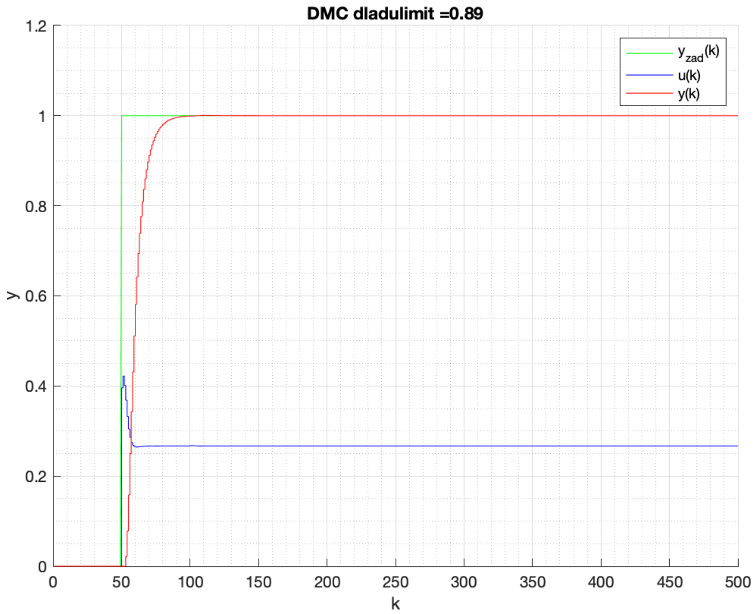

DMC dladulimit =0.98
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

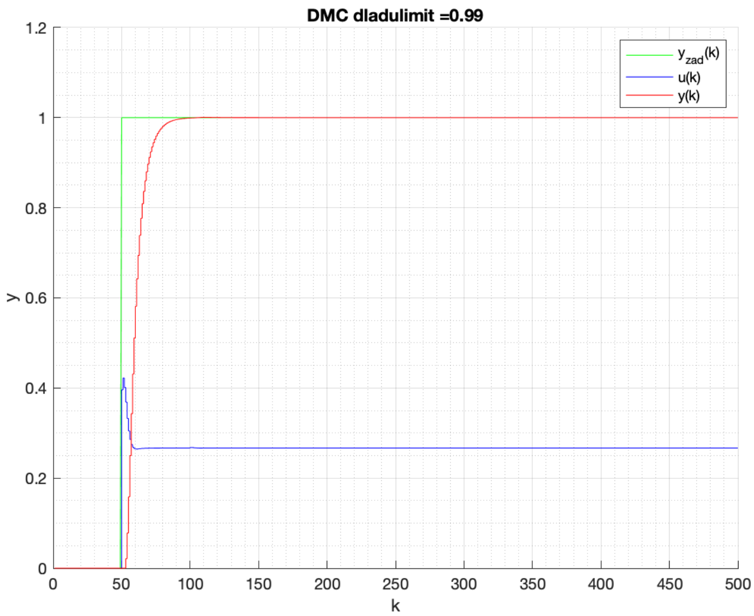

DMC dladulimit =0.88
y
k
$y_{zad}(k)$
u(k)
y(k)

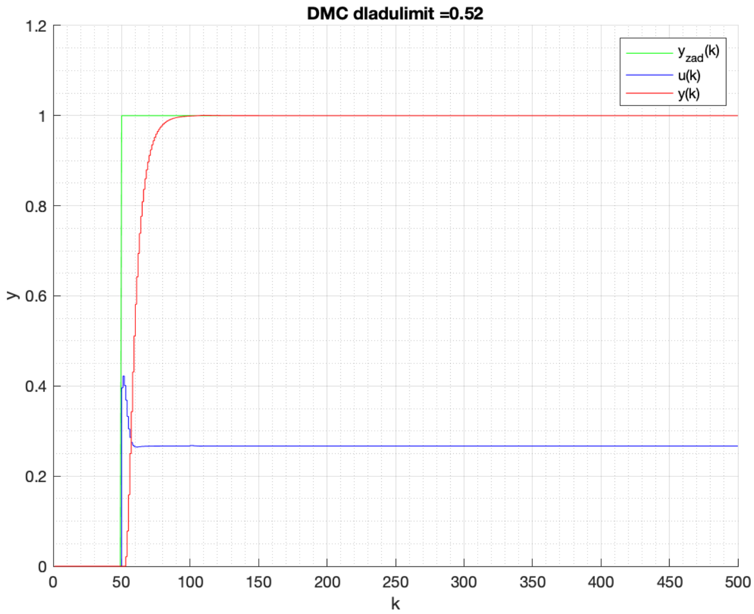

DMC dladulimit =0.43
y
k
$y_{zad}(k)$
u(k)
y(k)

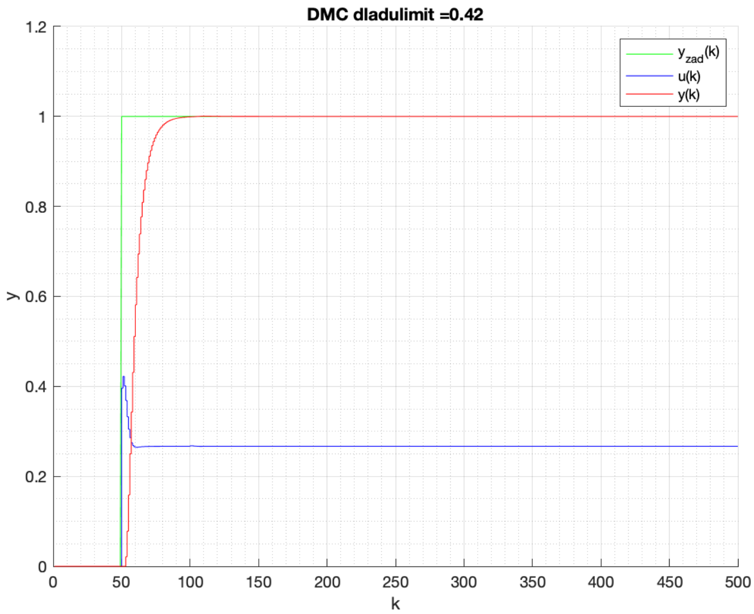

DMC dladulimit =0.53
$y_{zad}(k)$
u(k)
y(k)
y
k

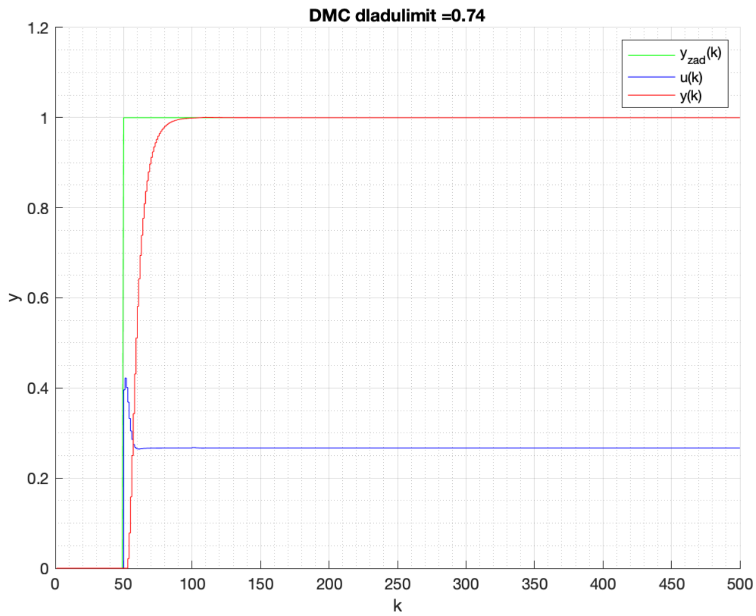

DMC dladulimit =0.9
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dladulimit =0.89
y
k
$y_{zad}(k)$
u(k)
y(k)

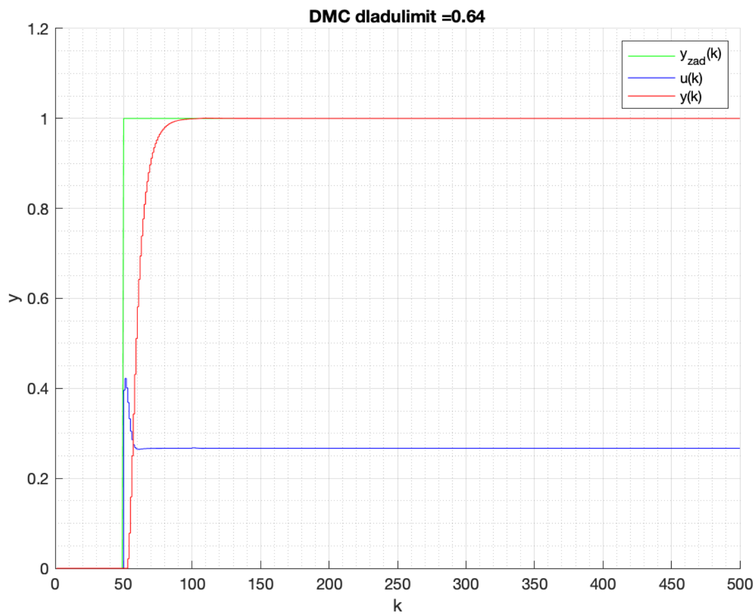

DMC dladulimit =0.99
y
k
$y_{zad}(k)$
u(k)
y(k)


DMC dladulimit =0.52
y
k
$y_{zad}(k)$
u(k)
y(k)
0
50
100
150
200
250
300
350
400
450
500
0.2
0.4
0.6
0.8
1
1.2

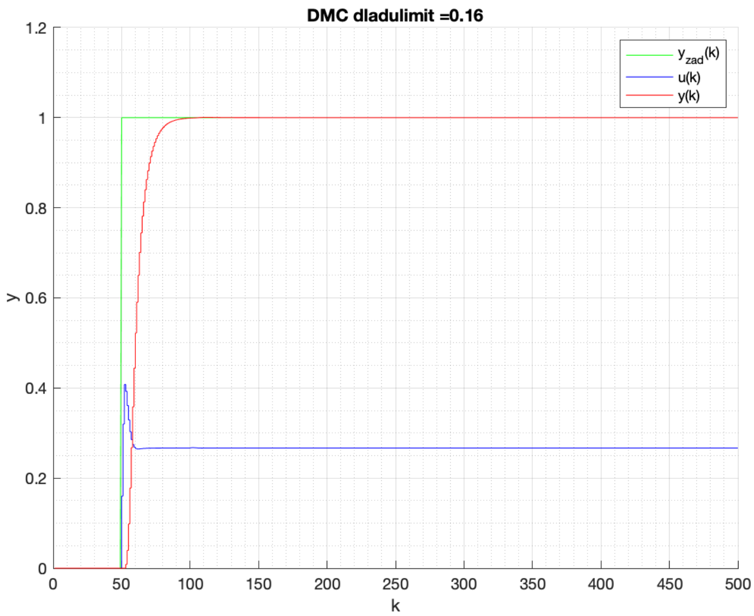

DMC dladulimit =0.42
y
k
$y_{zad}(k)$
u(k)
y(k)
0
50
100
150
200
250
300
350
400
450
500
0.2
0.4
0.6
0.8
1
1.2

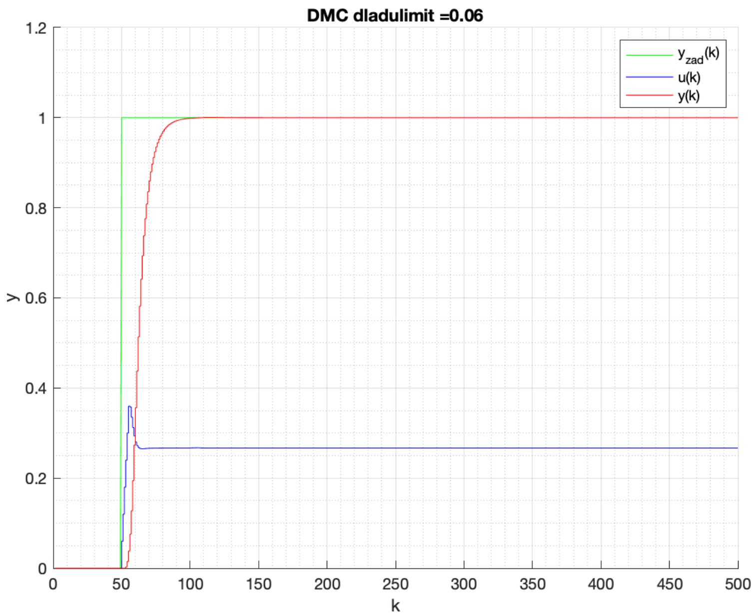


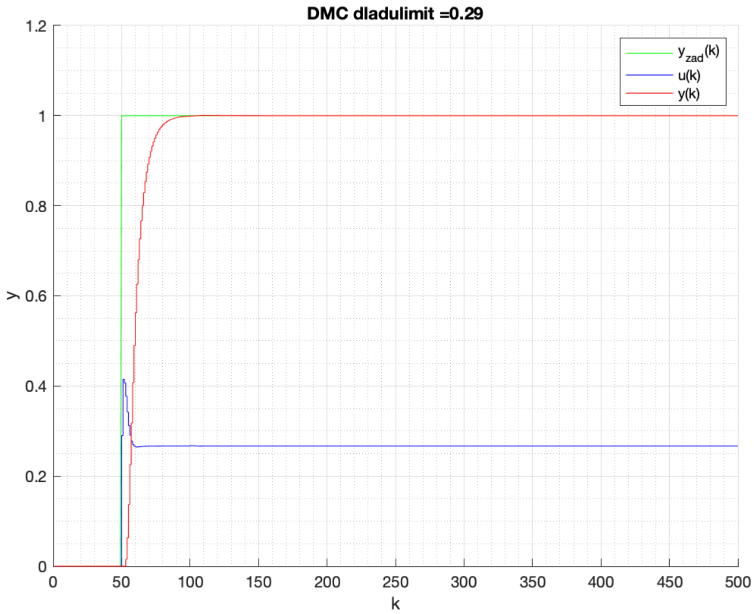
DMC dladulimit =0.74
y
k
$y_{zad}(k)$
u(k)
y(k)

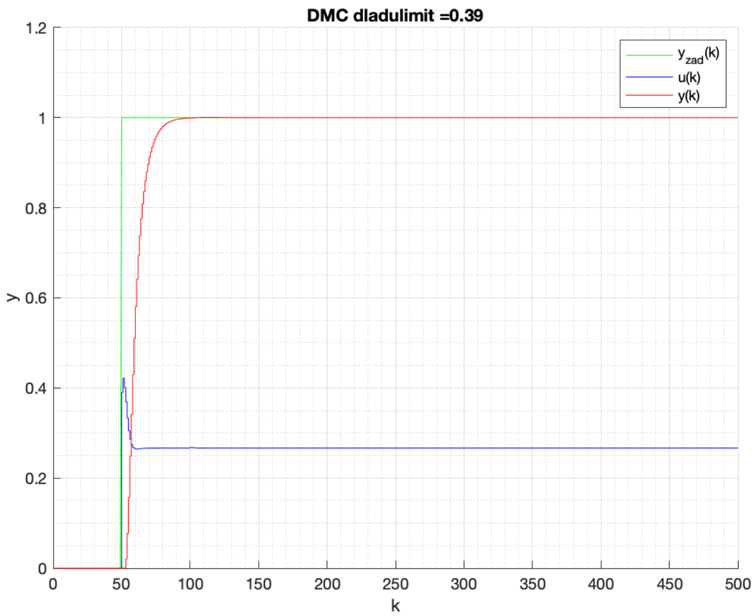


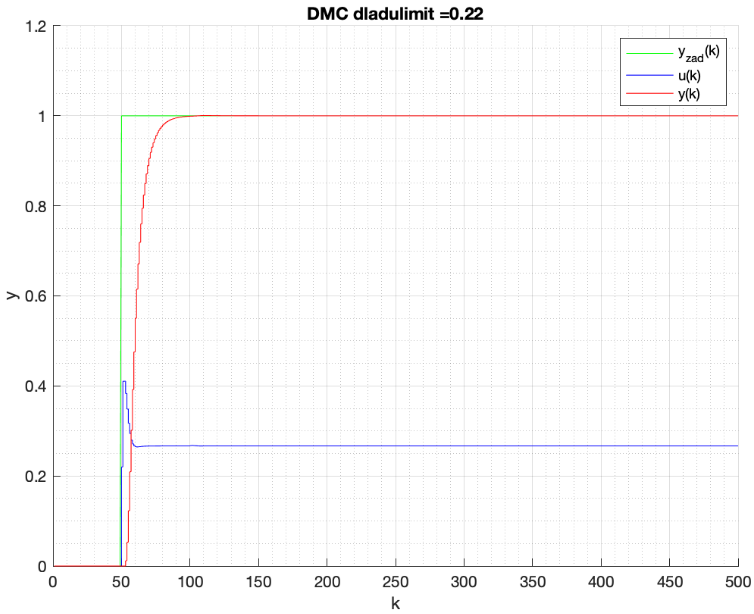
DMC dladulimit =0.64
y
k
$y_{zad}(k)$
u(k)
y(k)

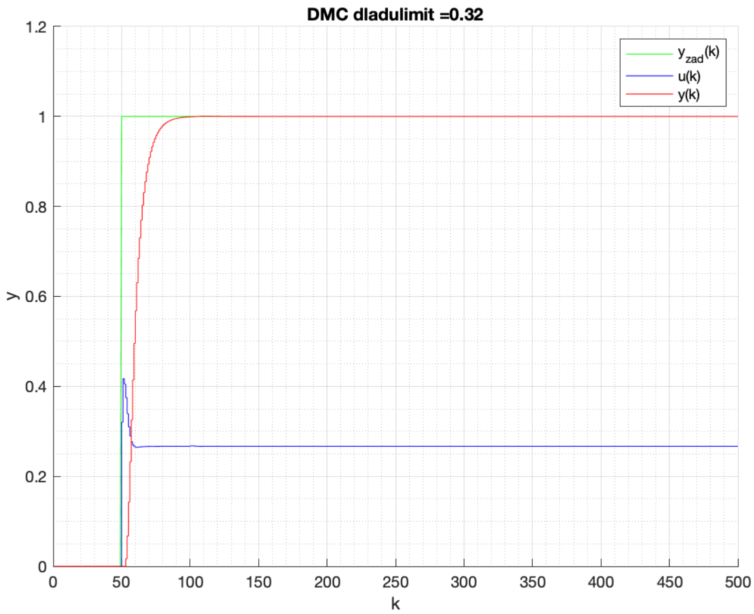

DMC dladulimit =0.16
$y_{zad}(k)$
u(k)
y(k)
y
k

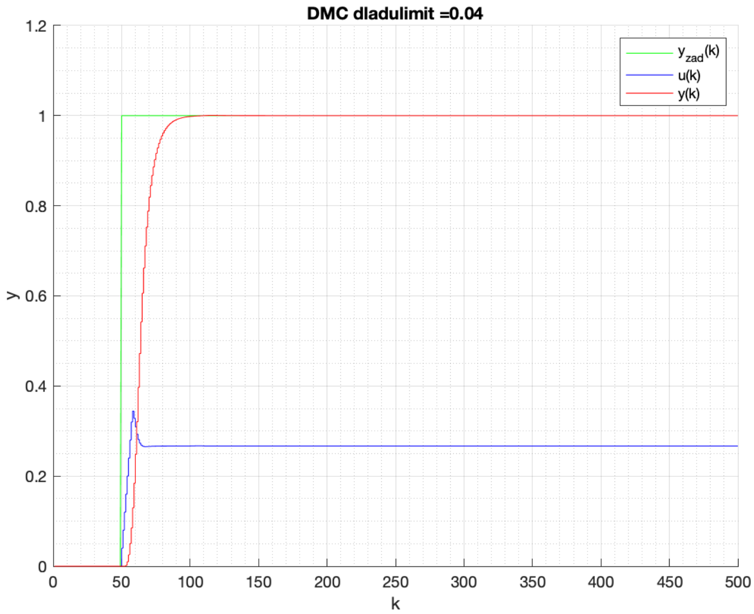

DMC dladulimit =0.06
$y_{zad}(k)$
u(k)
y(k)
y
k

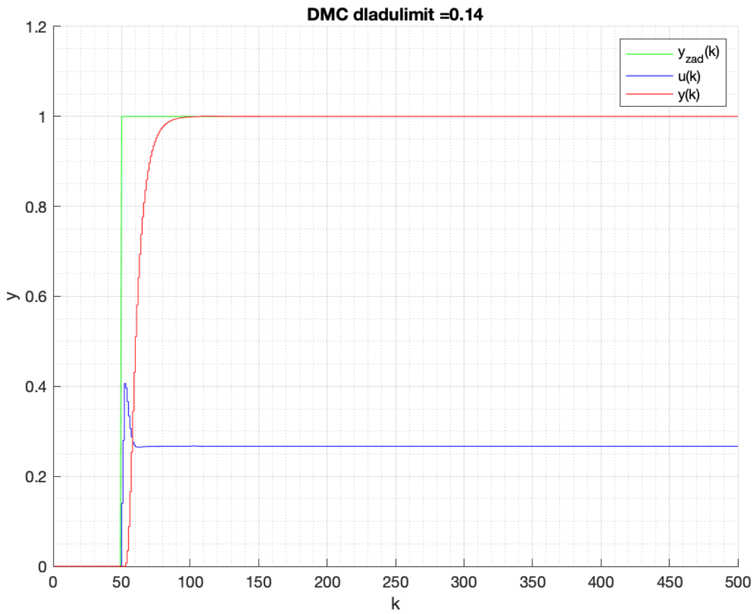

DMC dladulimit =0.29
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

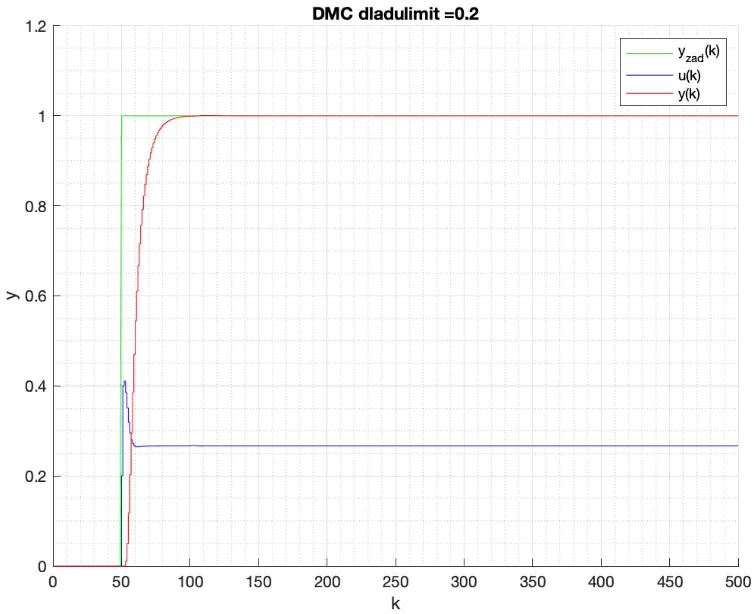

DMC dladulimit =0.39
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

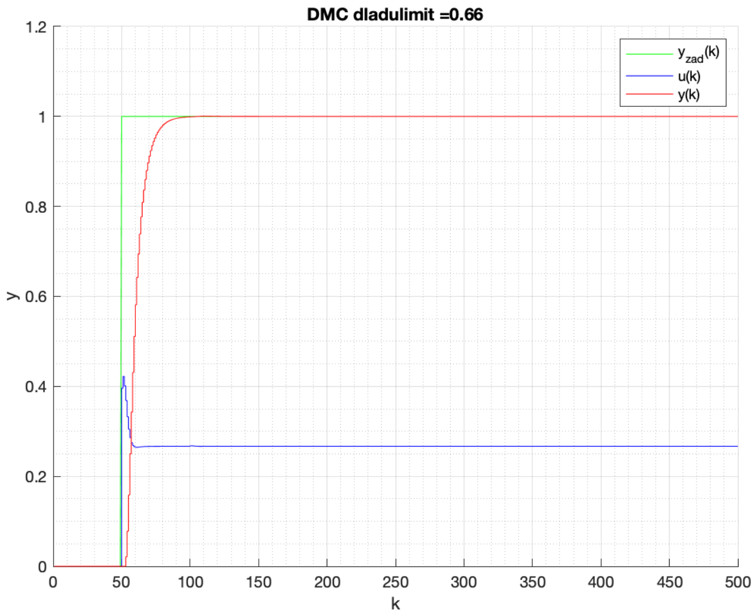

DMC dladulimit =0.22
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

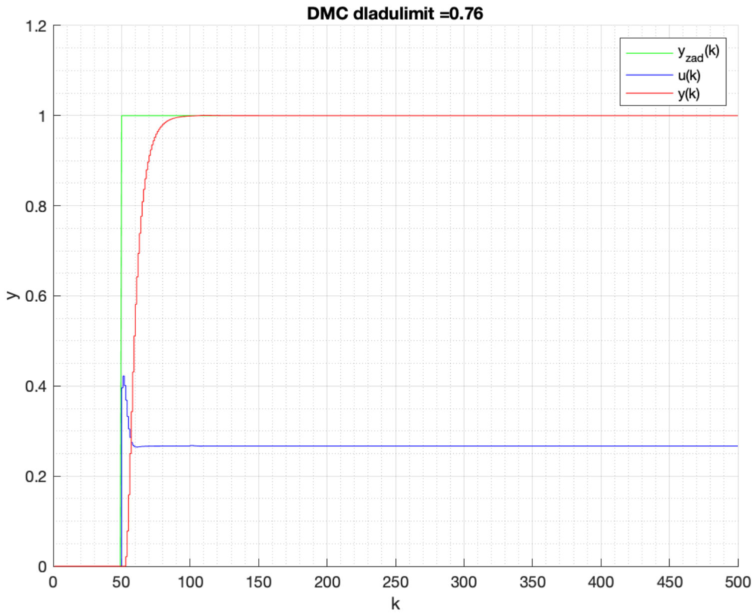

DMC dladulimit =0.32
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2


DMC dladulimit =0.04
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

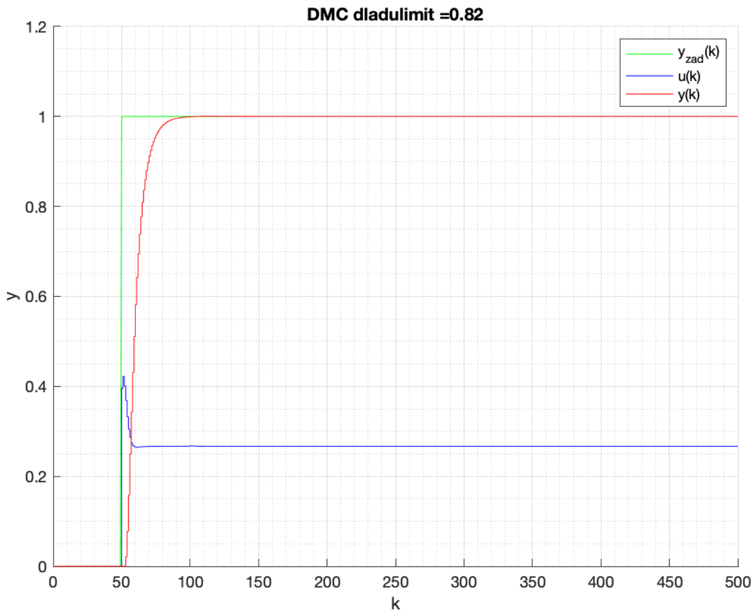

DMC dladulimit =0.14
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500


DMC dladulimit =0.2
y
k
$y_{zad}(k)$
u(k)
y(k)

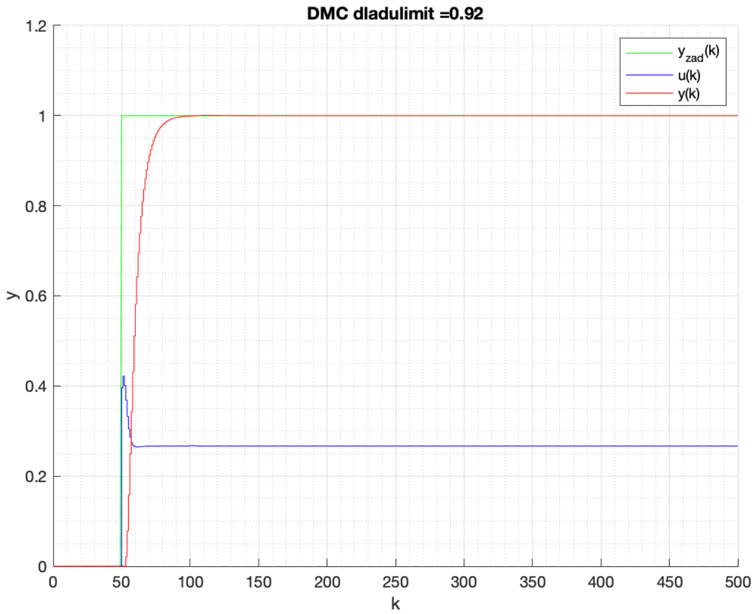

DMC dladulimit =0.66
y
k
$y_{zad}(k)$
u(k)
y(k)

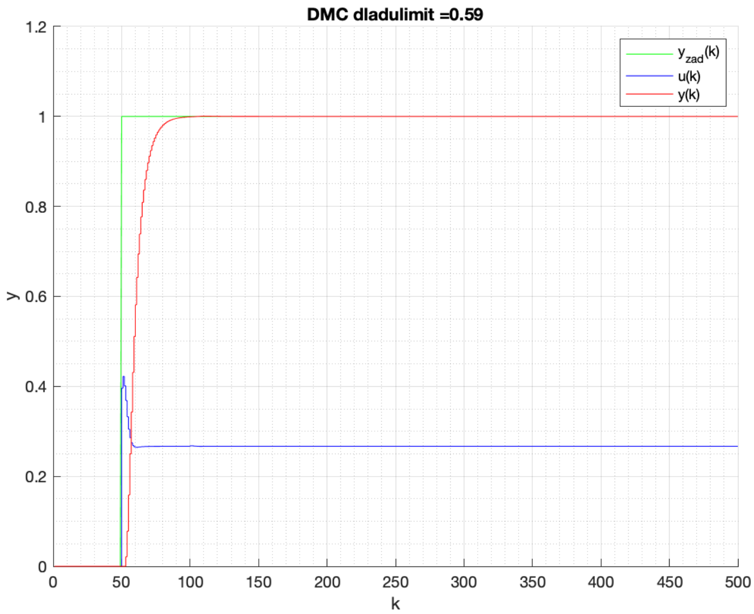


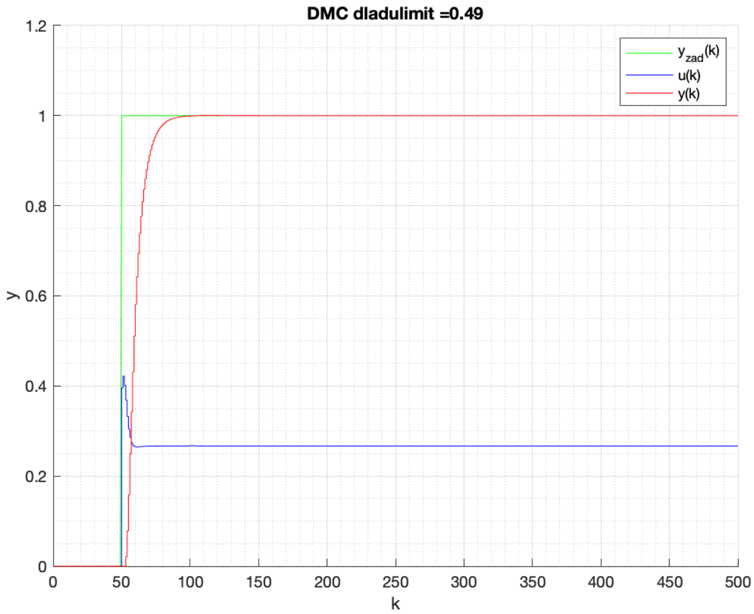
DMC dladulimit =0.76
$y_{zad}(k)$
u(k)
y(k)
y
k

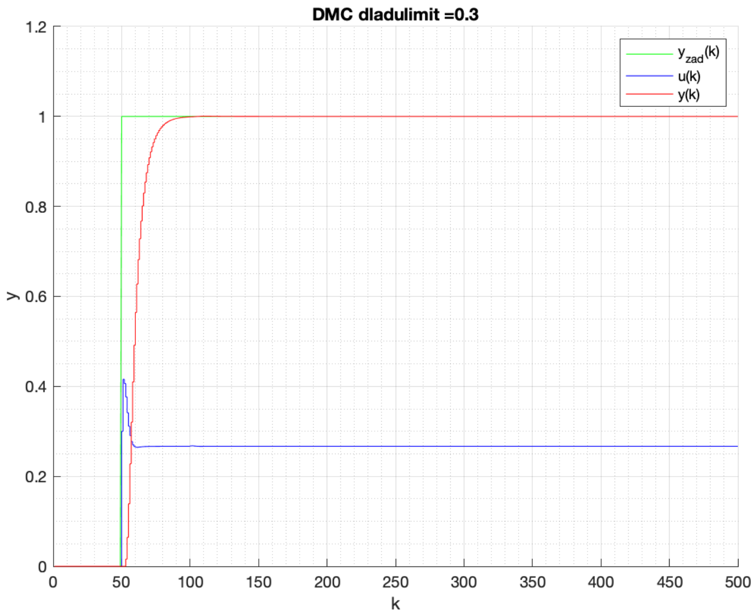


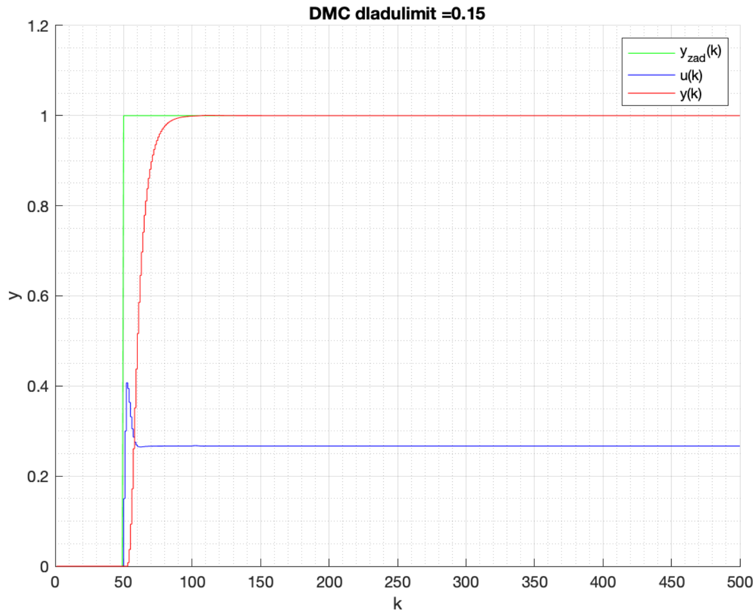
DMC dladulimit =0.82
$y_{zad}(k)$
u(k)
y(k)
y
k

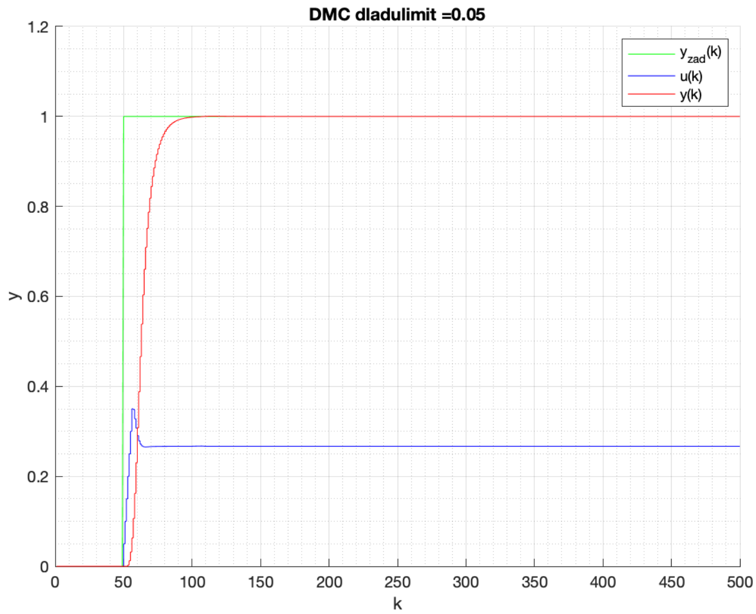

DMC dladulimit =0.92
y
k
$y_{zad}(k)$
u(k)
y(k)

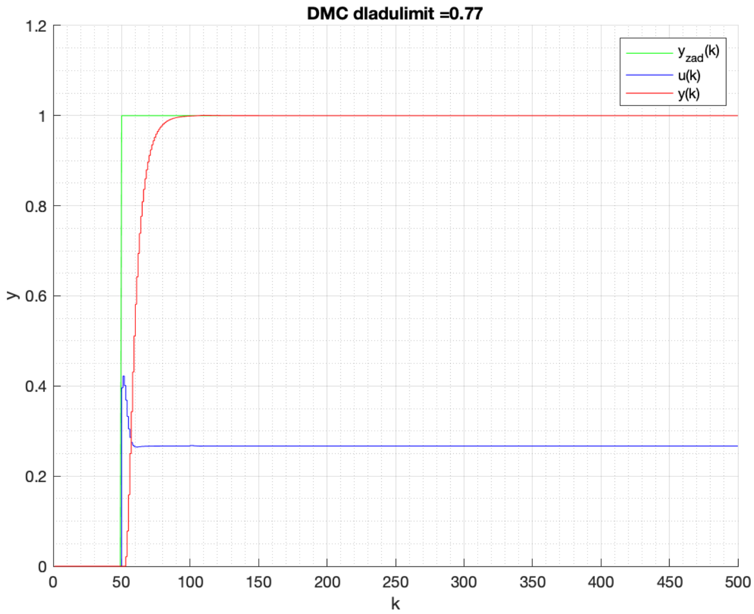

DMC dladulimit =0.59
y
k
$y_{zad}(k)$
u(k)
y(k)

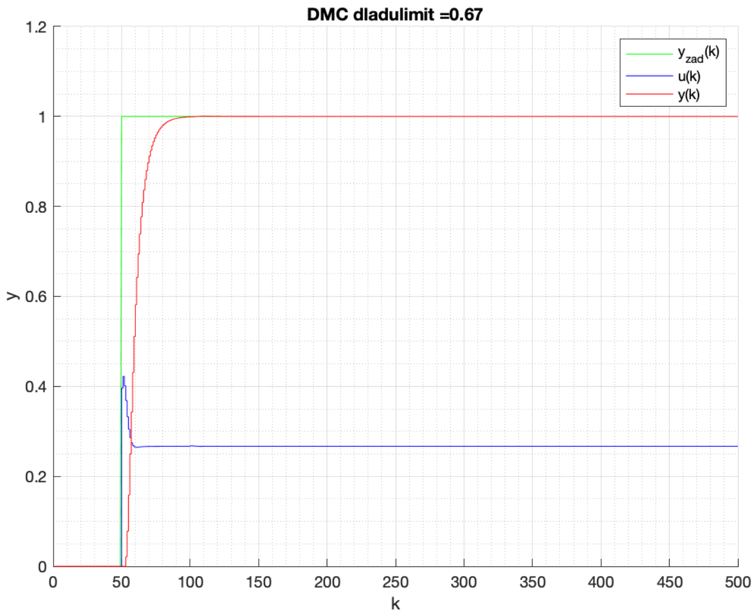

DMC dladulimit =0.49
y_zad(k)
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

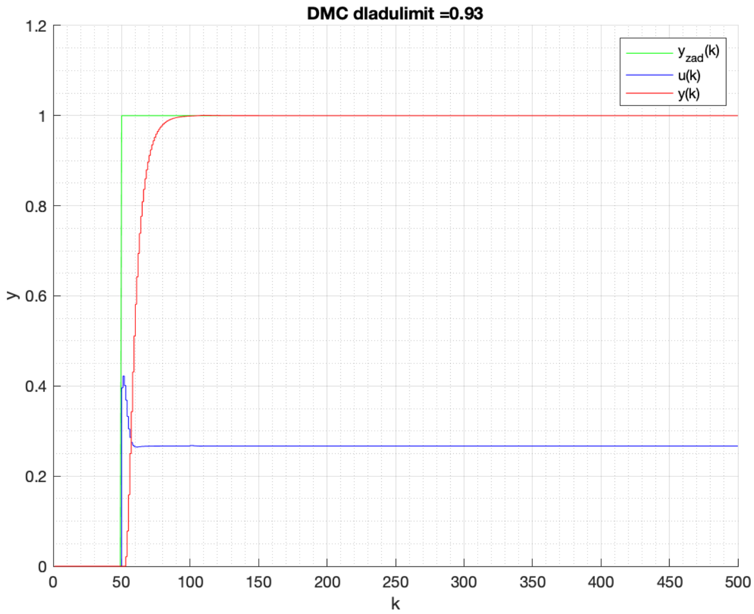

DMC dladulimit =0.3
y_zad(k)
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

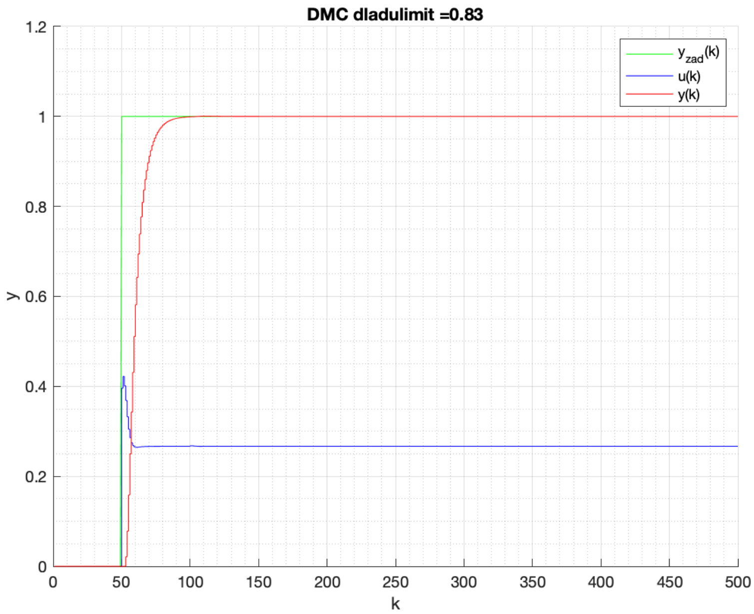

DMC dladulimit =0.15
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

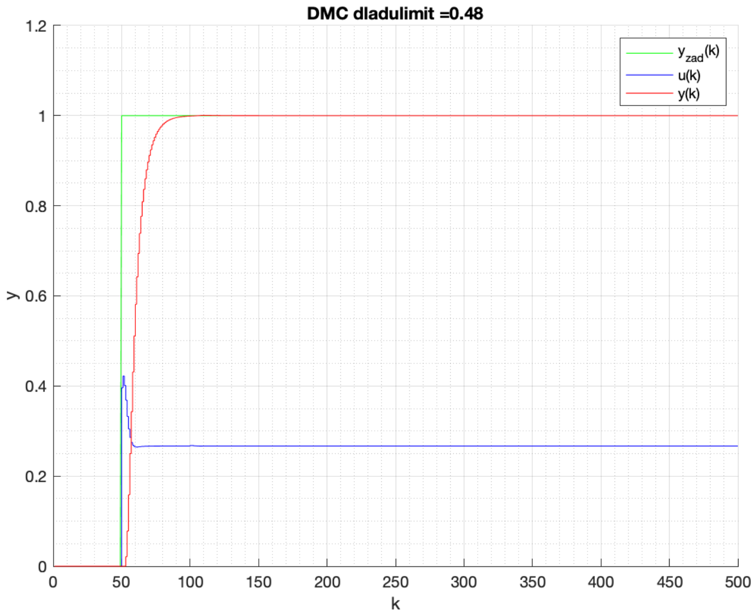

DMC dladulimit =0.05
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

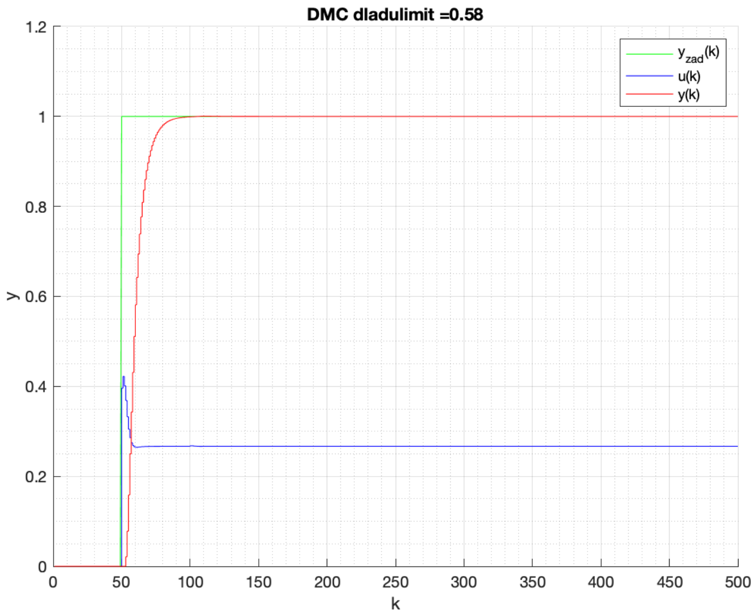

DMC dladulimit =0.77
y
k
$y_{zad}(k)$
u(k)
y(k)

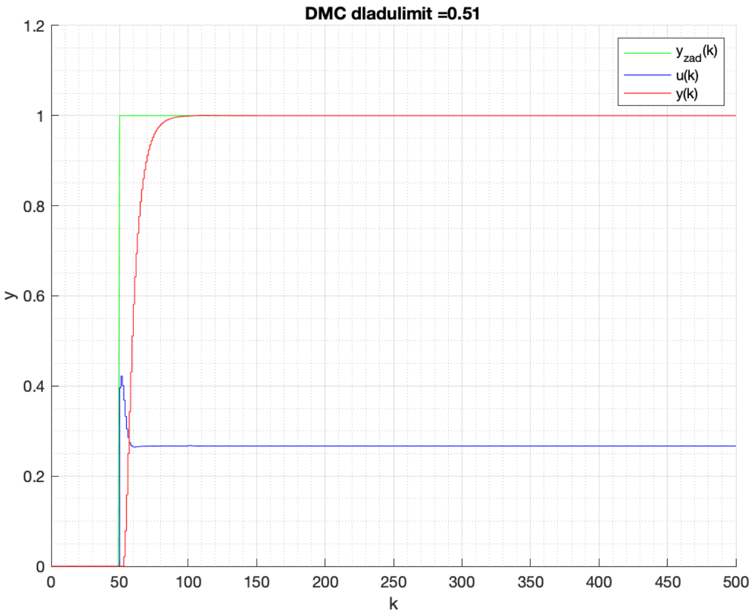

DMC dladulimit =0.67
y
k
$y_{zad}(k)$
u(k)
y(k)


DMC dladulimit =0.93
y
k
yzad(k)
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
50
100
150
200
250
300
350
400
450
500

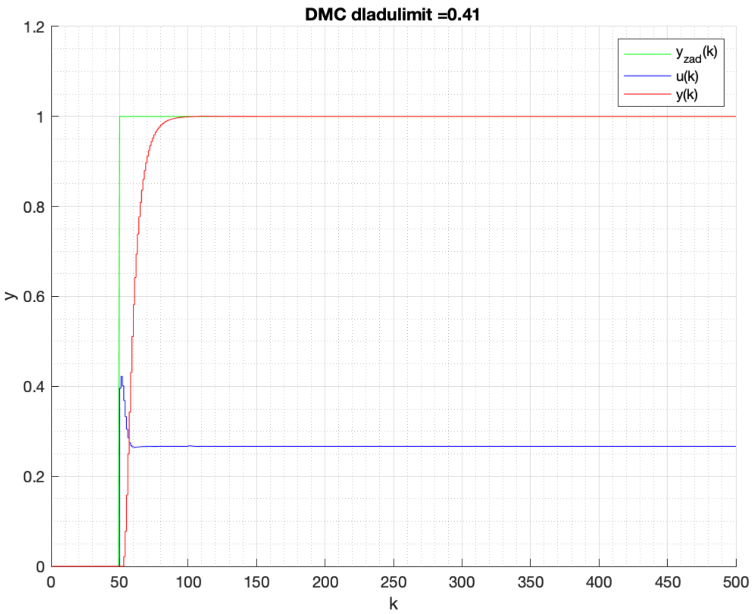

DMC dladulimit =0.83
y
k
yzad(k)
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
50
100
150
200
250
300
350
400
450
500


DMC dladulimit =0.48
y
k
$y_{zad}(k)$
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

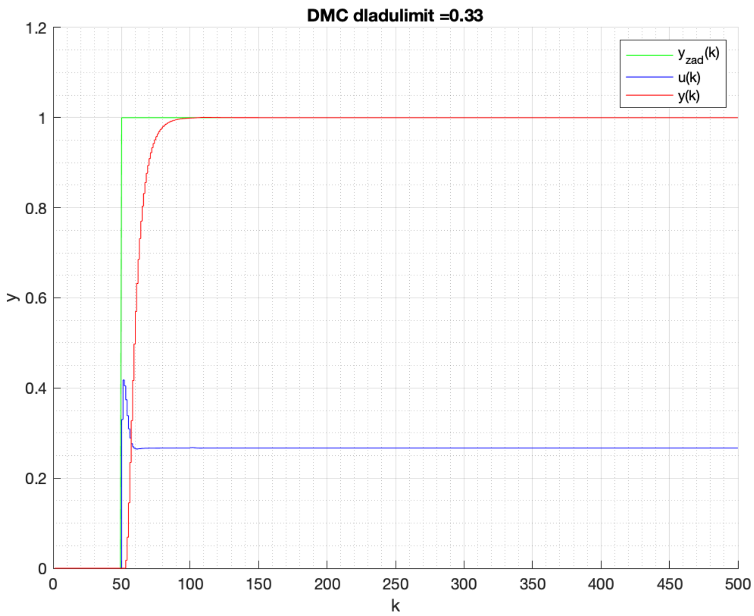

DMC dladulimit =0.58
y
k
$y_{zad}(k)$
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500



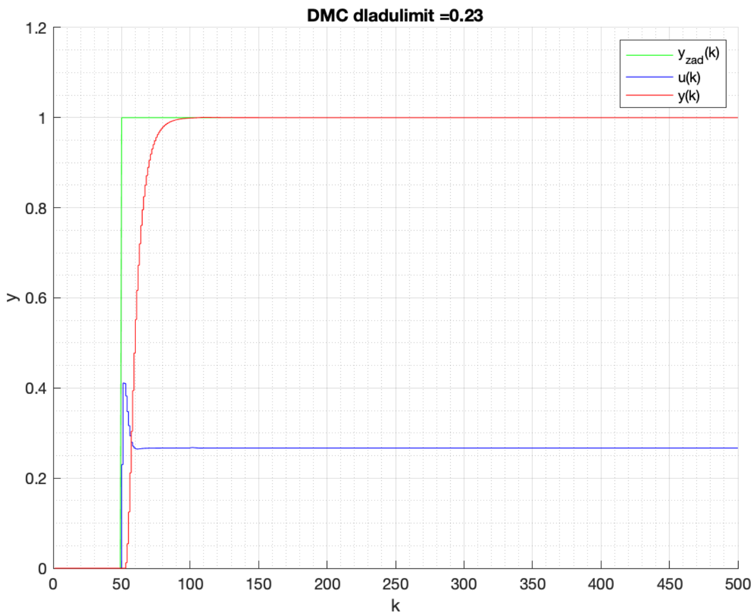
DMC dladulimit =0.51
y
k
$y_{zad}(k)$
u(k)
y(k)



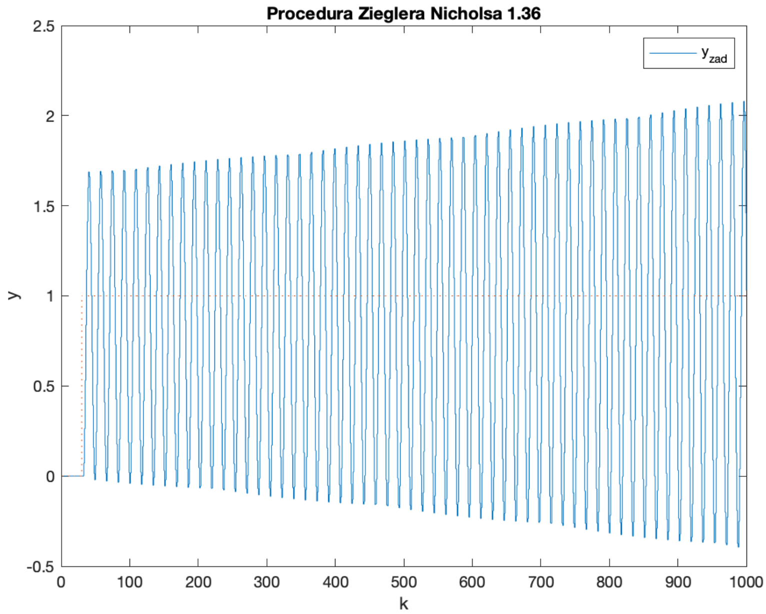
DMC dladulimit =0.41
y
k
$y_{zad}(k)$
u(k)
y(k)

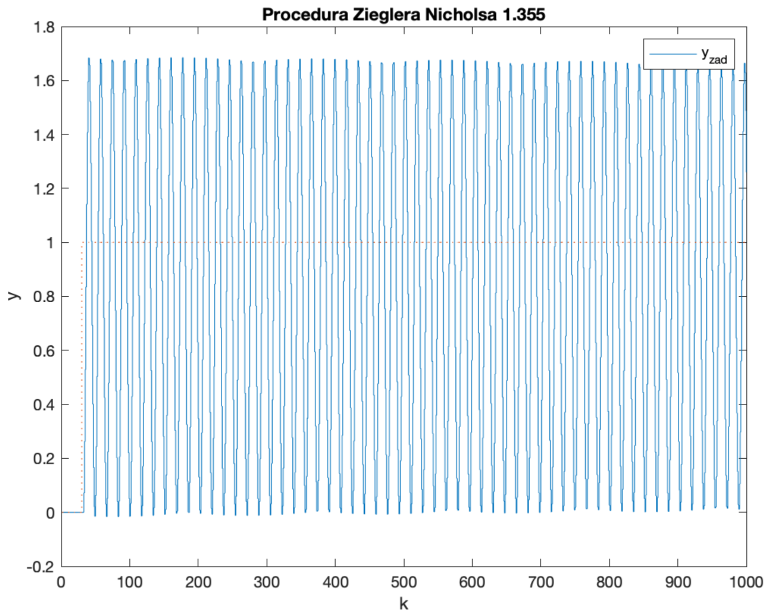


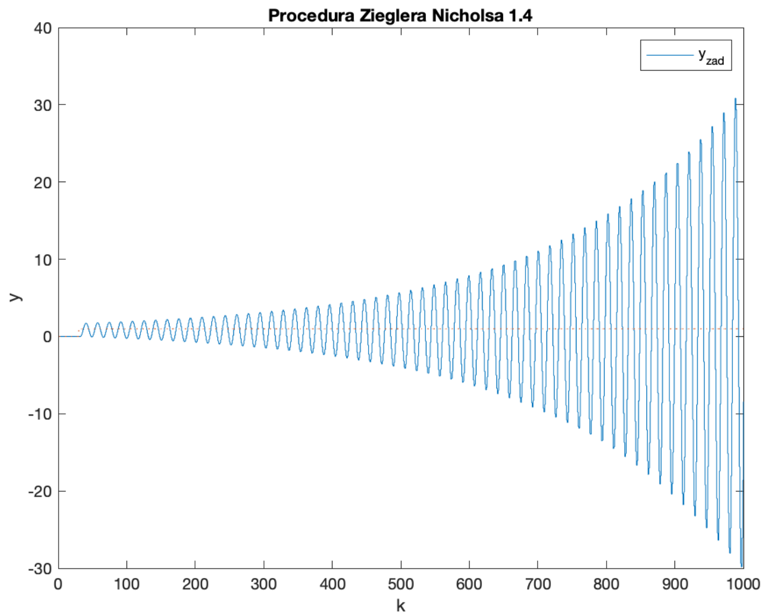
DMC dladulimit =0.33
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

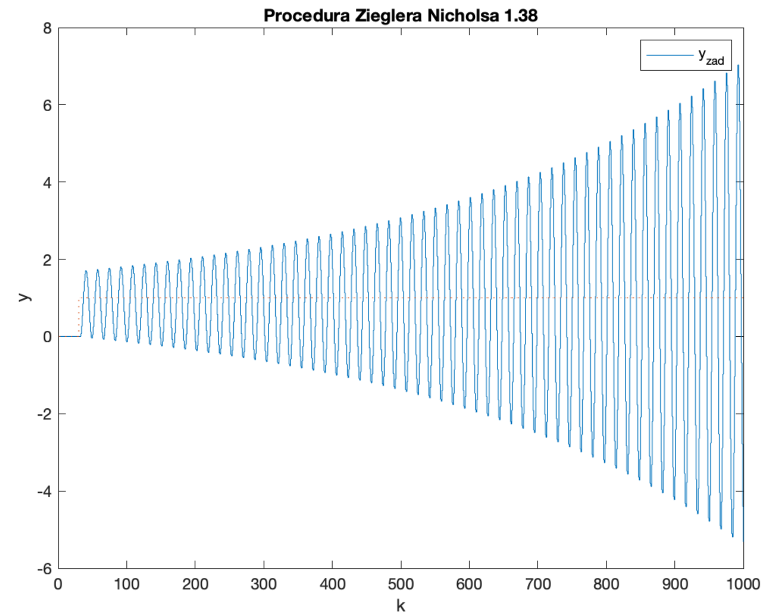


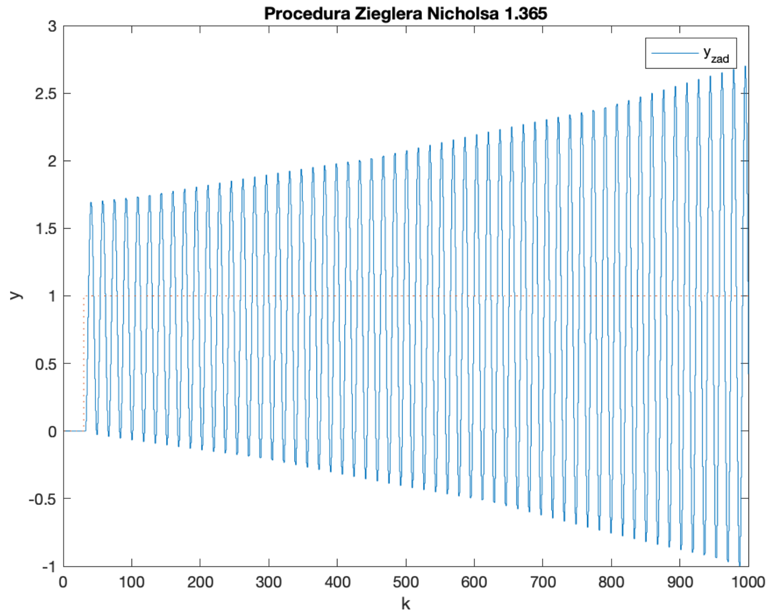
DMC dladulimit =0.23
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

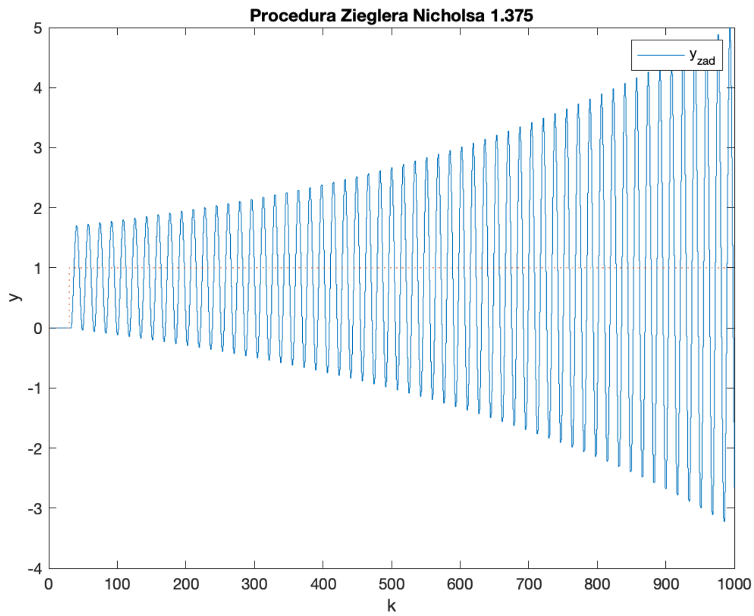

Procedura Zieglera Nicholsa 1.36
y_{zad}
y
k
2.5
2
1.5
1
0.5
0
-0.5
0
100
200
300
400
500
600
700
800
900
1000

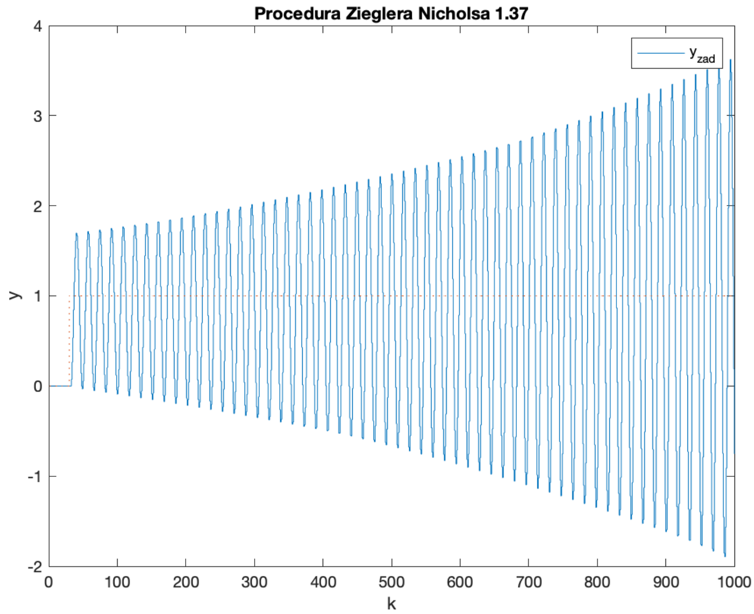

Procedura Zieglera Nicholsa 1.355
y_{zad}
y
k
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
100
200
300
400
500
600
700
800
900
1000

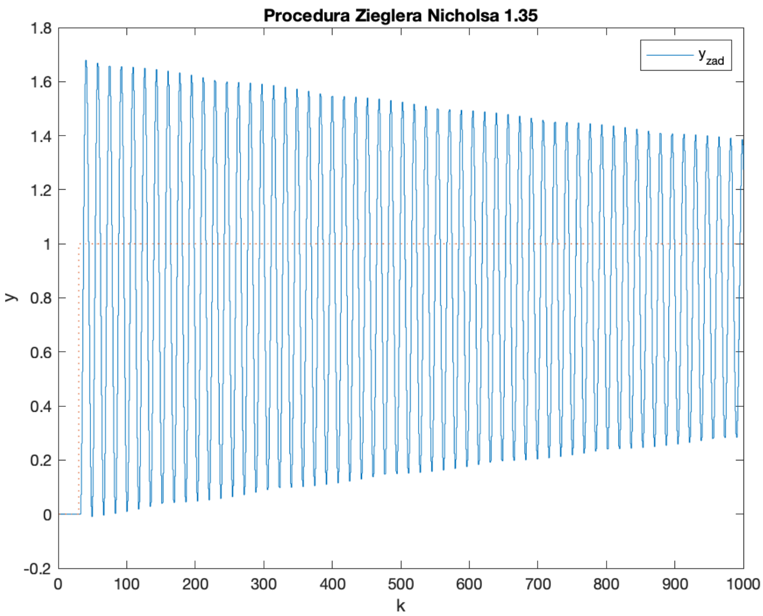

Procedura Zieglera Nicholsa 1.4
y
k
y_{zad}
40
30
20
10
0
-10
-20
-30
0
100
200
300
400
500
600
700
800
900
1000

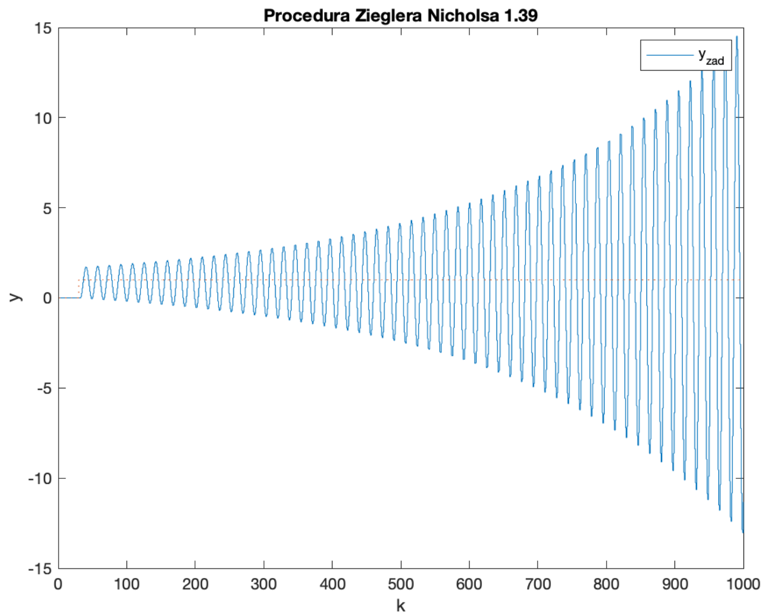

Procedura Zieglera Nicholsa 1.38
y
k
y_{zad}
8
6
4
2
0
-2
-4
-6
0
100
200
300
400
500
600
700
800
900
1000

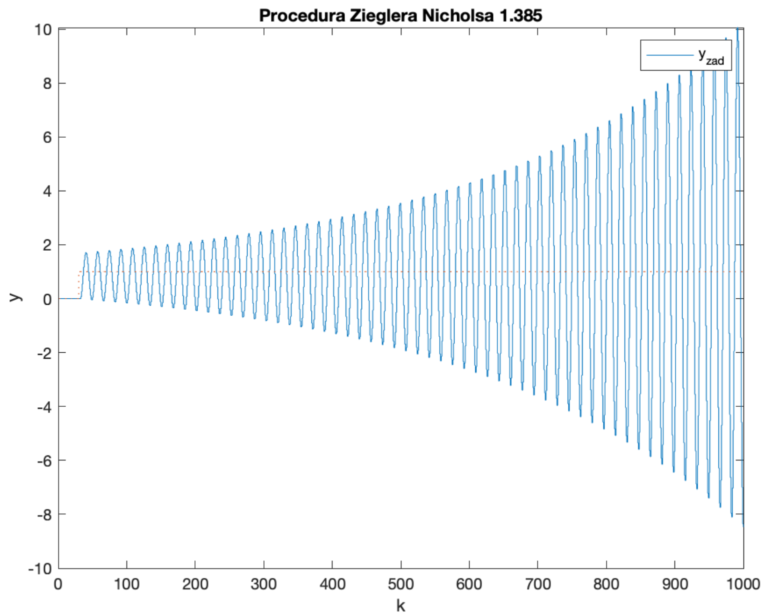

Procedura Zieglera Nicholsa 1.365
y
k
y_{zad}
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
100
200
300
400
500
600
700
800
900
1000

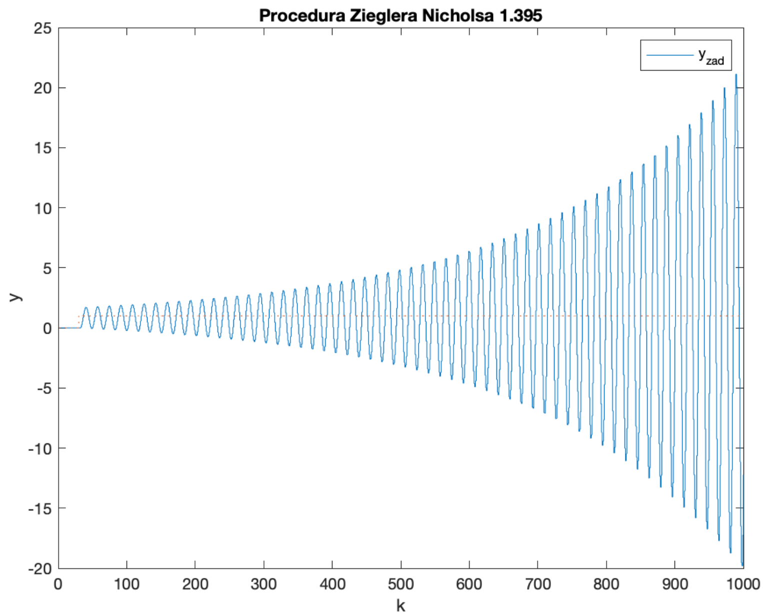

Procedura Zieglera Nicholsa 1.375
y
k
y_{zad}
5
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000

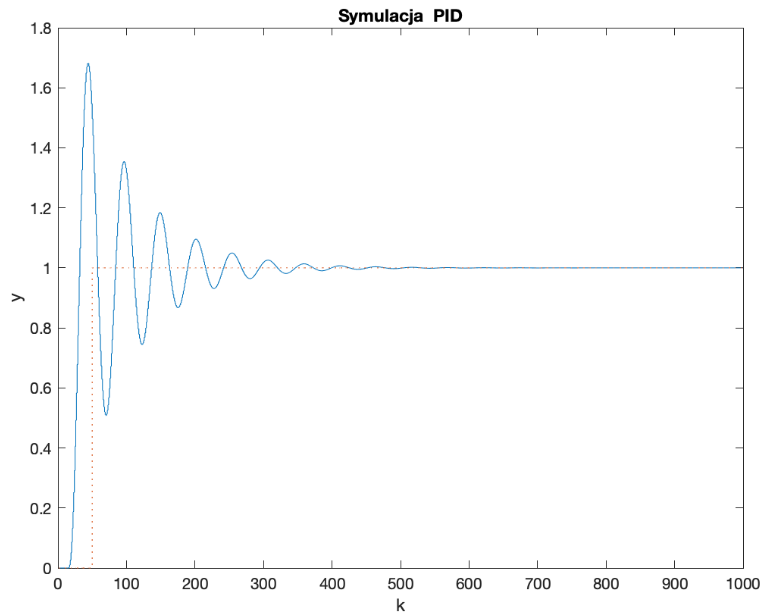

Procedura Zieglera Nicholsa 1.37
y
k
y_{zad}
4
3
2
1
0
-1
-2
0
100
200
300
400
500
600
700
800
900
1000

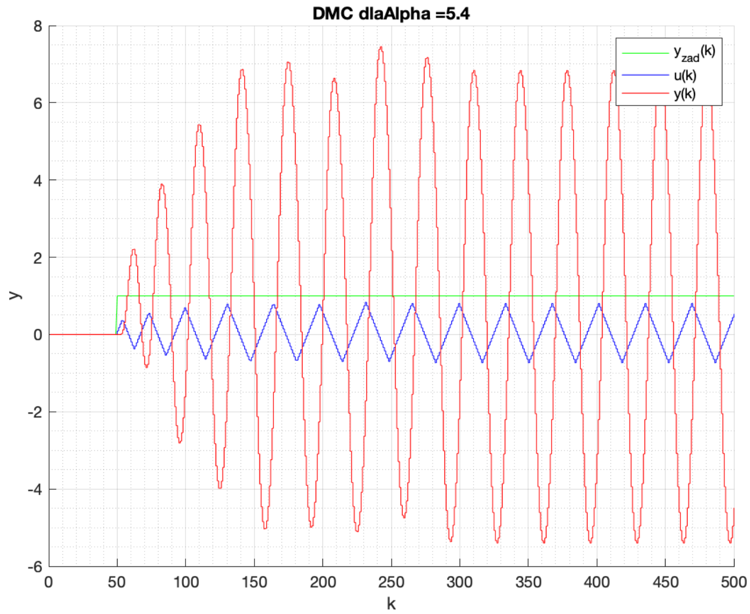

Procedura Zieglera Nicholsa 1.35
y
k
y_{zad}
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
100
200
300
400
500
600
700
800
900
1000

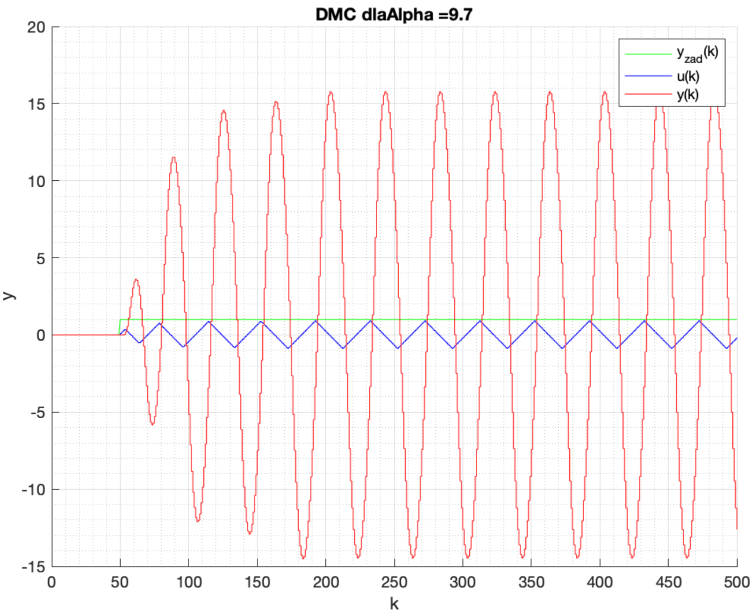

Procedura Zieglera Nicholsa 1.39
y_{zad}
y
k
15
10
5
0
-5
-10
-15
0
100
200
300
400
500
600
700
800
900
1000

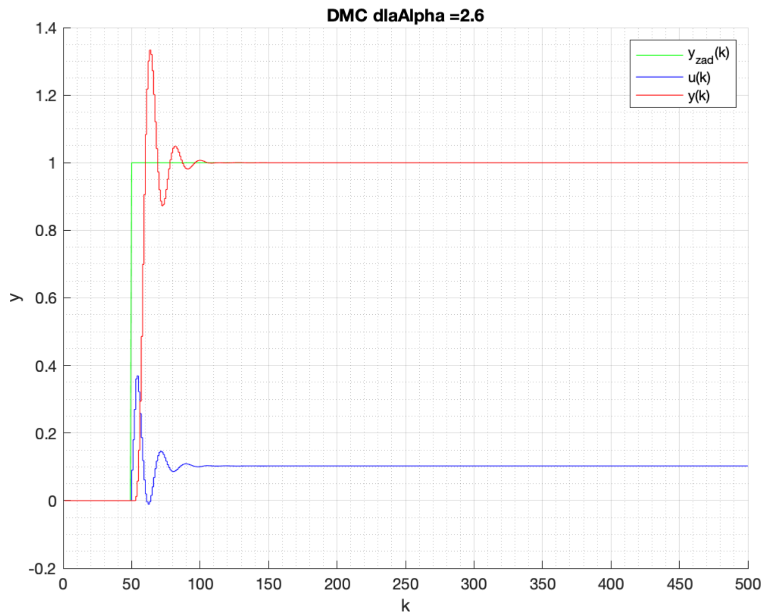

Procedura Zieglera Nicholsa 1.385
y_{zad}
y
k
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
100
200
300
400
500
600
700
800
900
1000

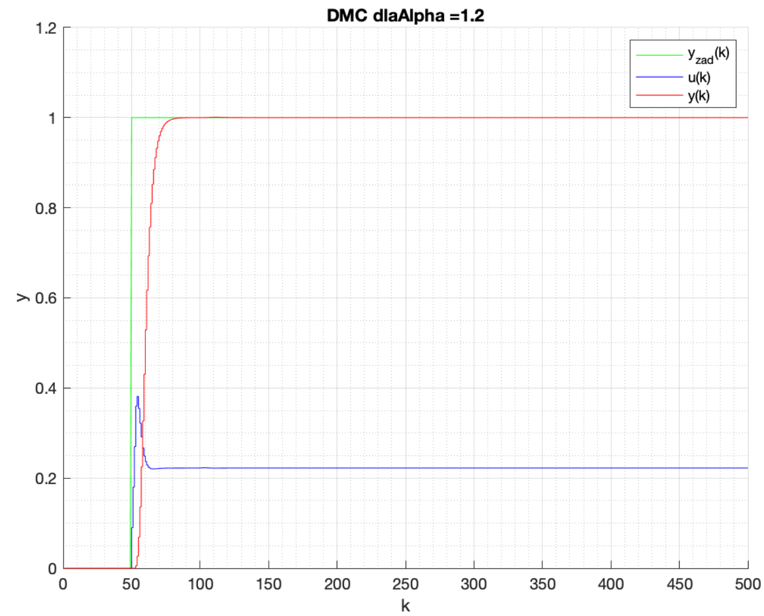

Procedura Zieglera Nicholsa 1.395
y_{zad}
y
k
25
20
15
10
5
0
-5
-10
-15
-20
0
100
200
300
400
500
600
700
800
900
1000

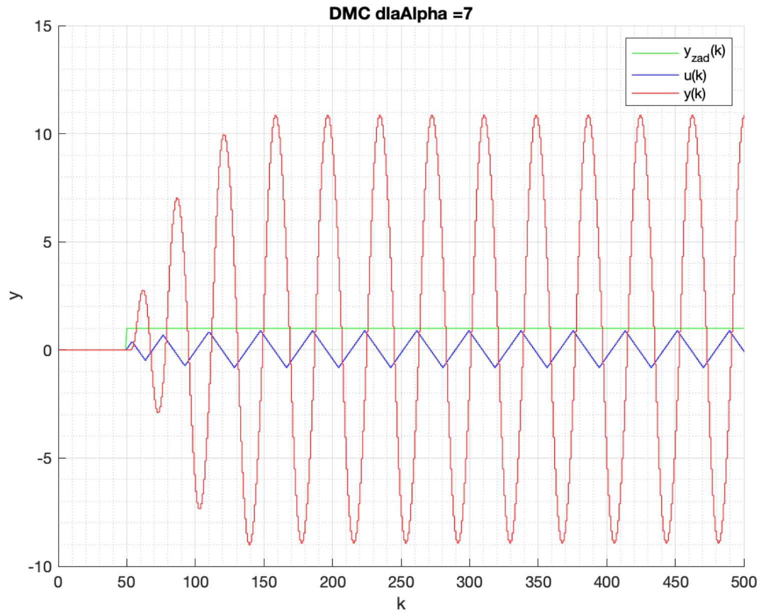

Symulacja PID
y
k
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
500
600
700
800
900
1000

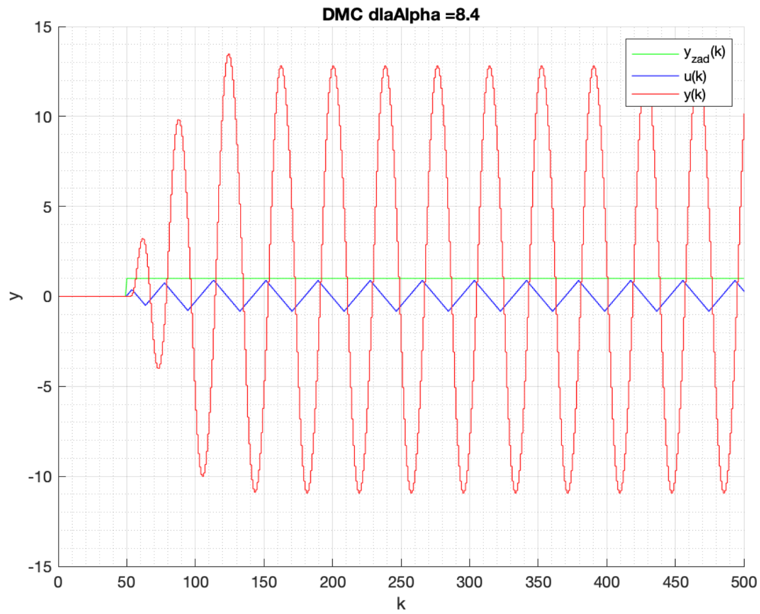

DMC dlaAlpha =5.4
$y_{zad}(k)$
u(k)
y(k)
y
k

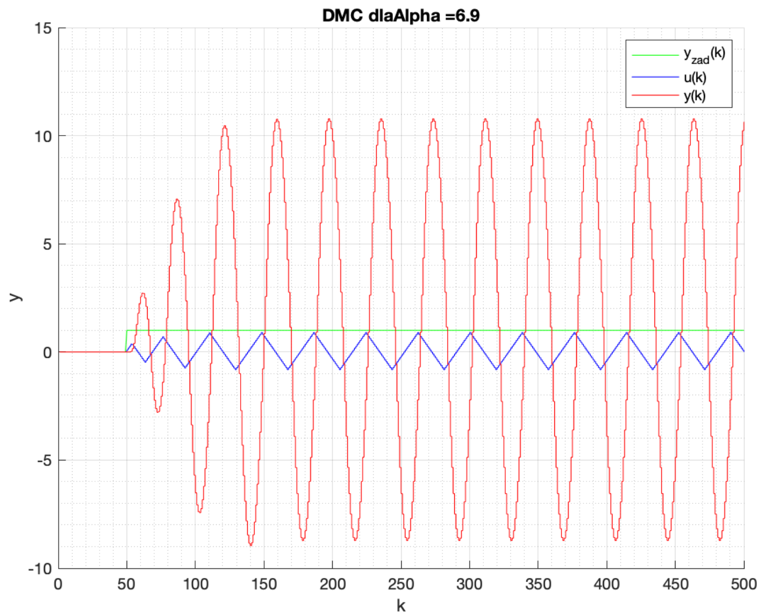

DMC dlaAlpha =9.7
$y_{zad}(k)$
u(k)
y(k)
y
k

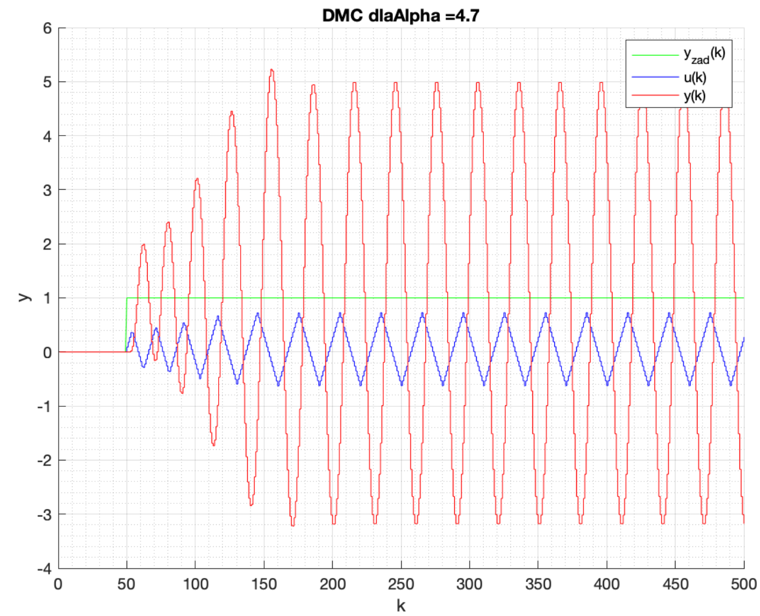

DMC dlaAlpha =2.6
y
k
$y_{zad}(k)$
u(k)
y(k)

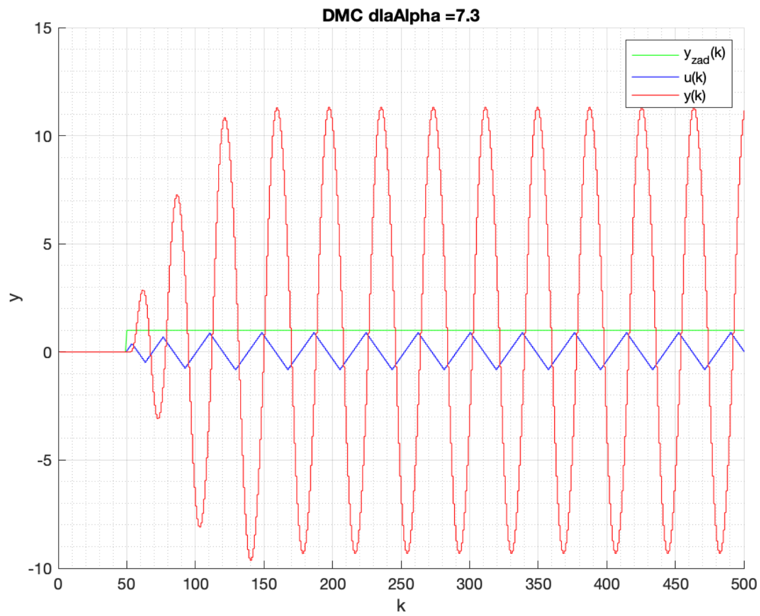

DMC dlaAlpha =1.2
y
k
$y_{zad}(k)$
u(k)
y(k)


DMC dlaAlpha =7
y_zad(k)
u(k)
y(k)
15
10
5
0
-5
-10
0
50
100
150
200
250
300
350
400
450
500
k
y

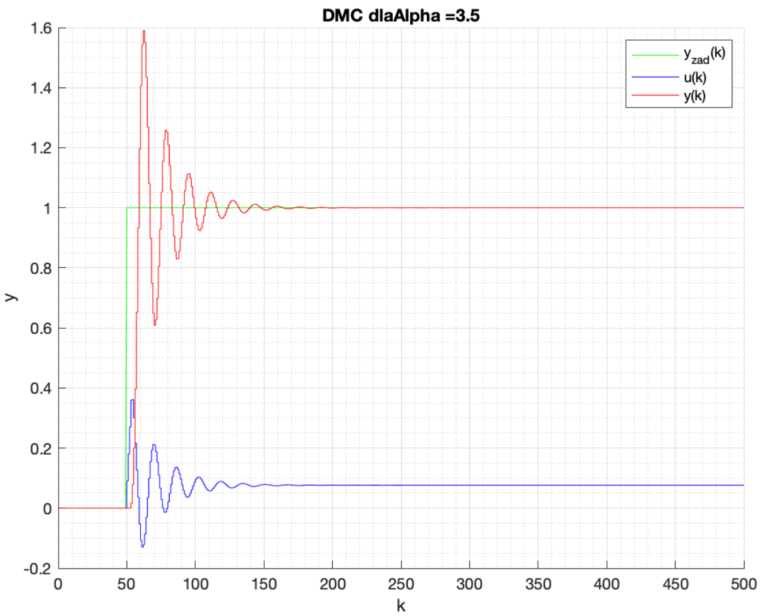

DMC dlaAlpha =8.4
y_zad(k)
u(k)
y(k)
15
10
5
0
-5
-10
-15
0
50
100
150
200
250
300
350
400
450
500
k
y


DMC dlaAlpha =6.9
$y_{zad}(k)$
u(k)
y(k)
y
k

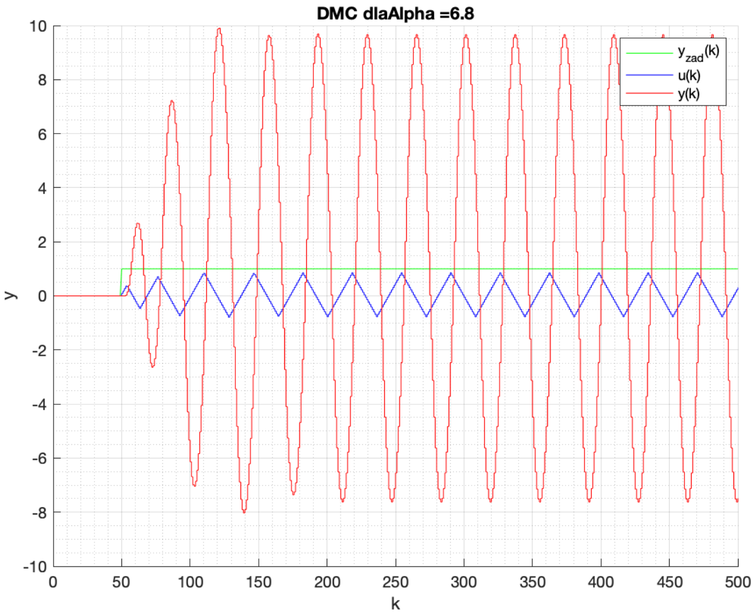

DMC dlaAlpha =4.7
$y_{zad}(k)$
u(k)
y(k)
y
k

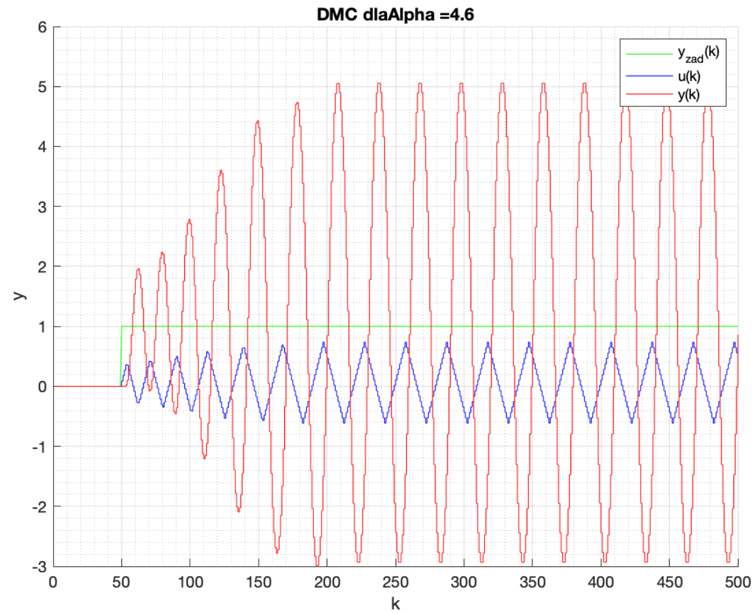


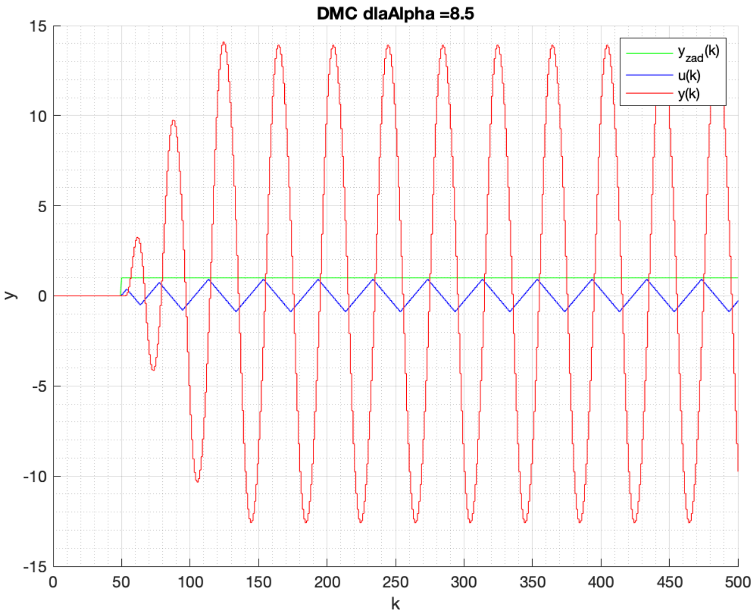
DMC dlaAlpha =7.3
$y_{zad}(k)$
u(k)
y(k)
y
k

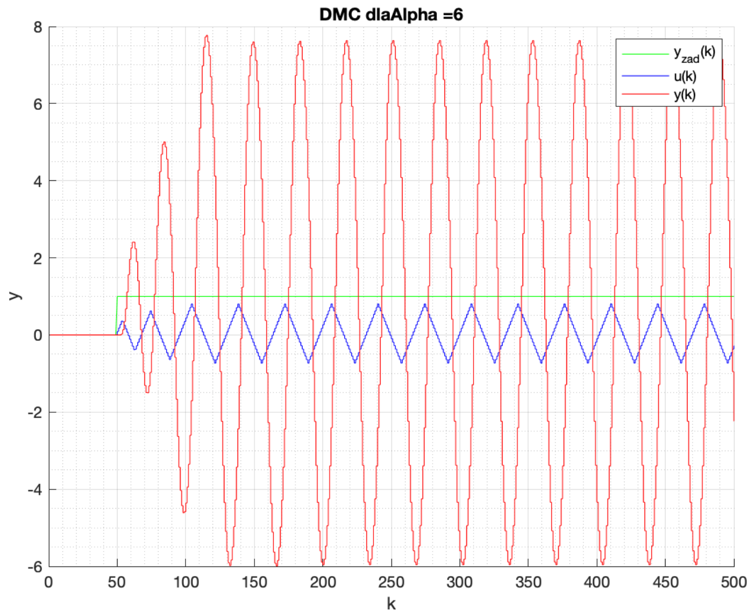


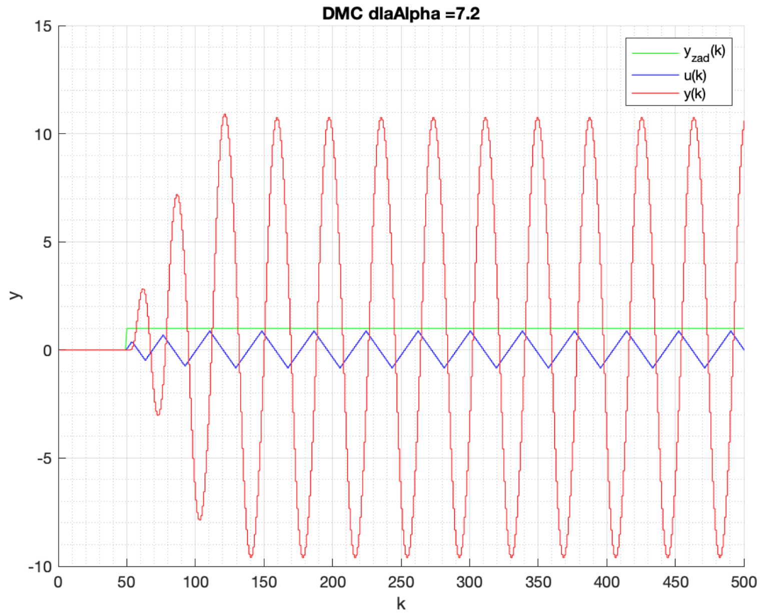
DMC dlaAlpha =3.5
$y_{zad}(k)$
u(k)
y(k)
y
k

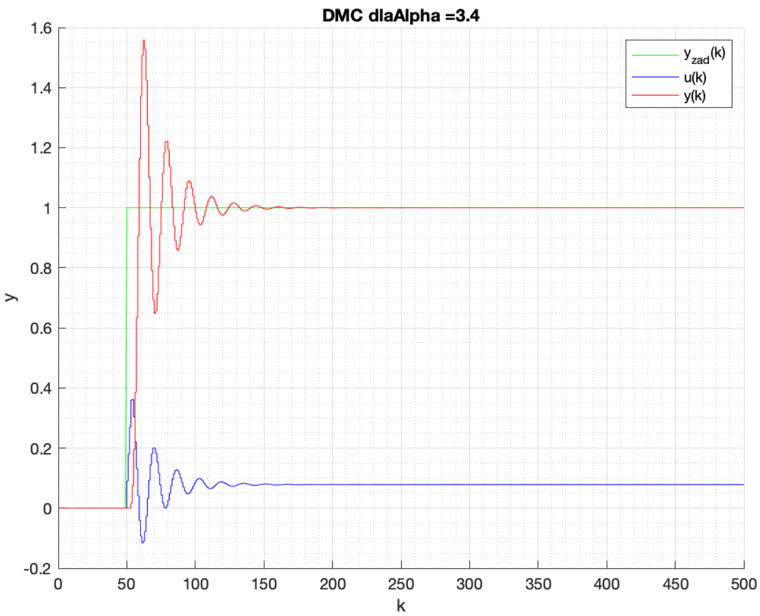

DMC dlaAlpha =6.8
y
k
y_zad(k)
u(k)
y(k)

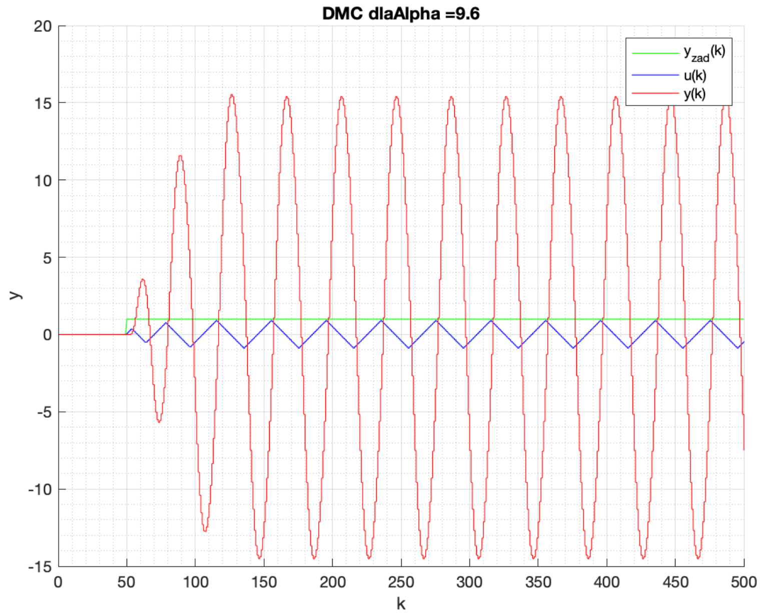

DMC dlaAlpha =4.6
y
k
y_zad(k)
u(k)
y(k)

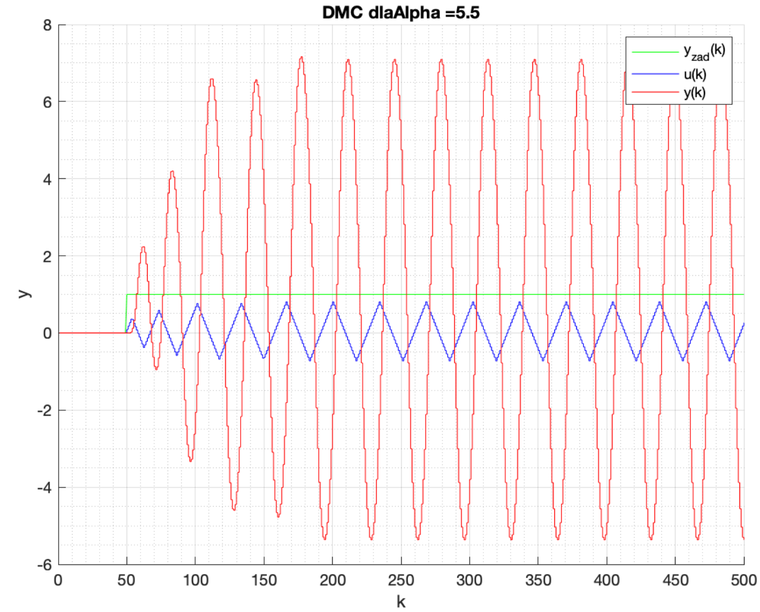

DMC dlaAlpha =8.5
y
k
15
10
5
0
-5
-10
-15
0
50
100
150
200
250
300
350
400
450
500
y_zad(k)
u(k)
y(k)

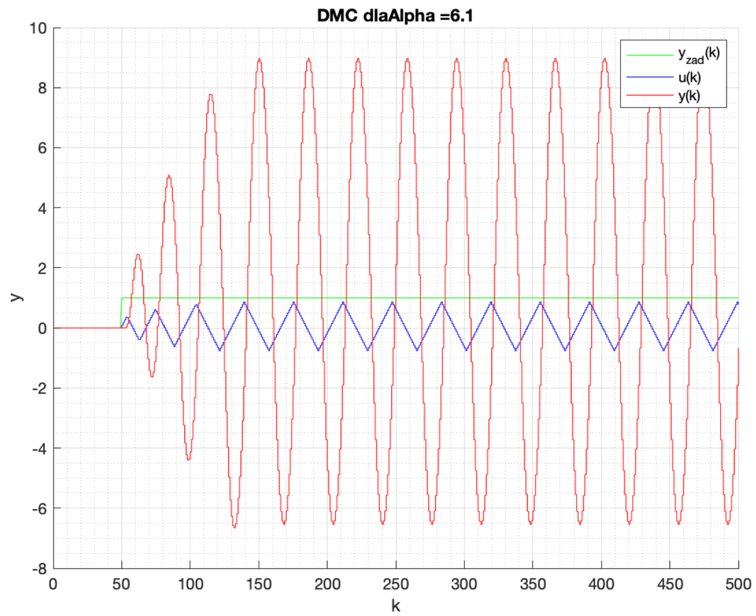

DMC dlaAlpha =6
y
k
8
6
4
2
0
-2
-4
-6
0
50
100
150
200
250
300
350
400
450
500
y_zad(k)
u(k)
y(k)


DMC dlaAlpha =7.2
$y_{zad}(k)$
u(k)
y(k)
y
k

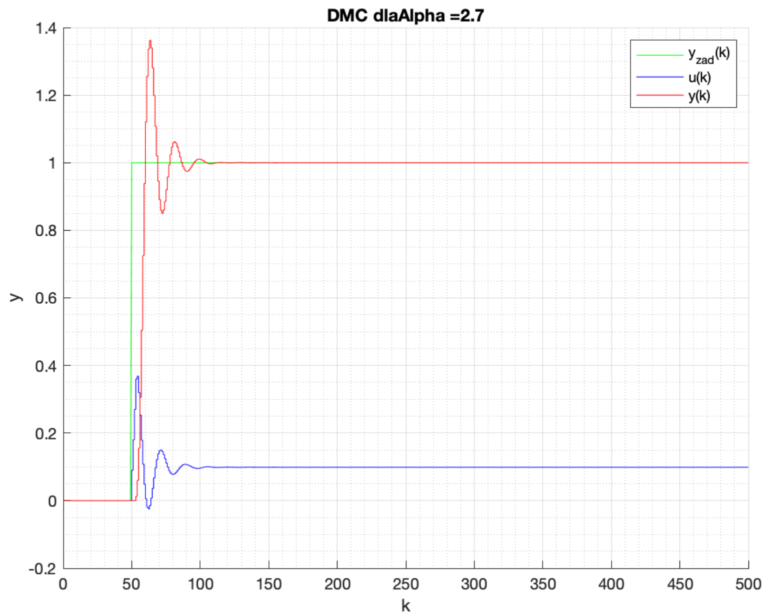

DMC dlaAlpha =3.4
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dlaAlpha =9.6
y
k
y_zad(k)
u(k)
y(k)

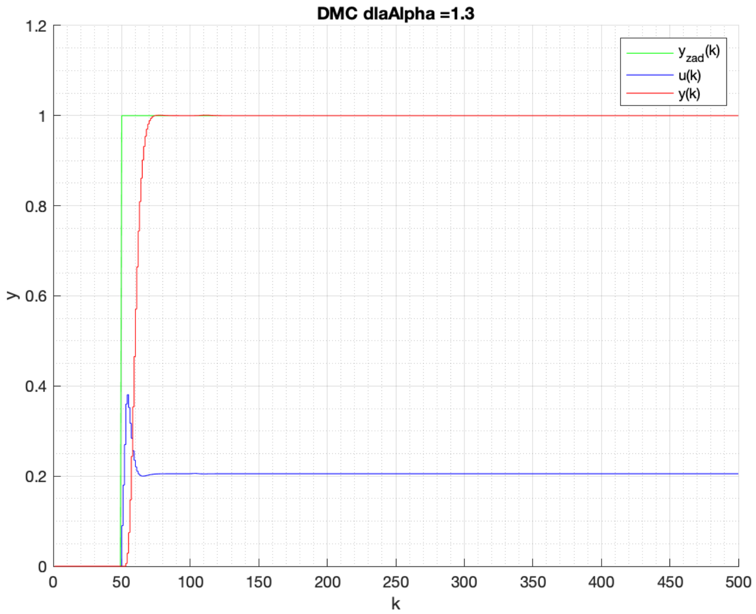

DMC dlaAlpha =5.5
y
k
y_zad(k)
u(k)
y(k)

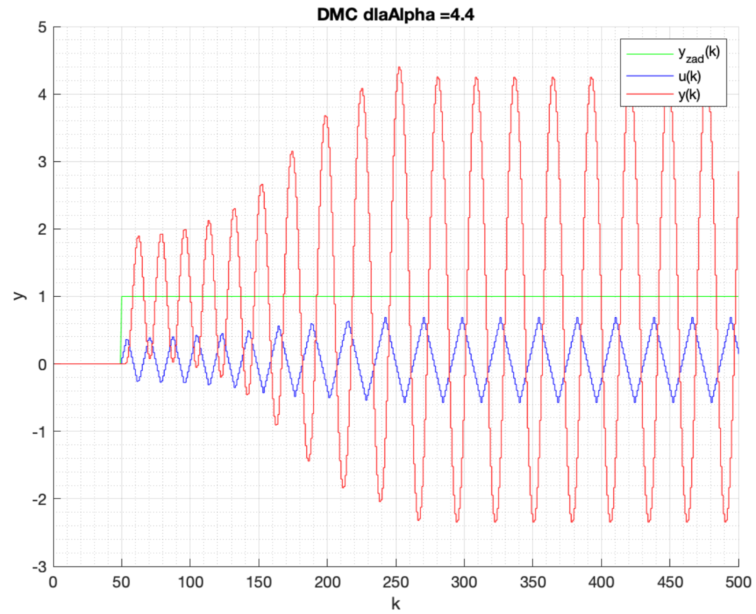


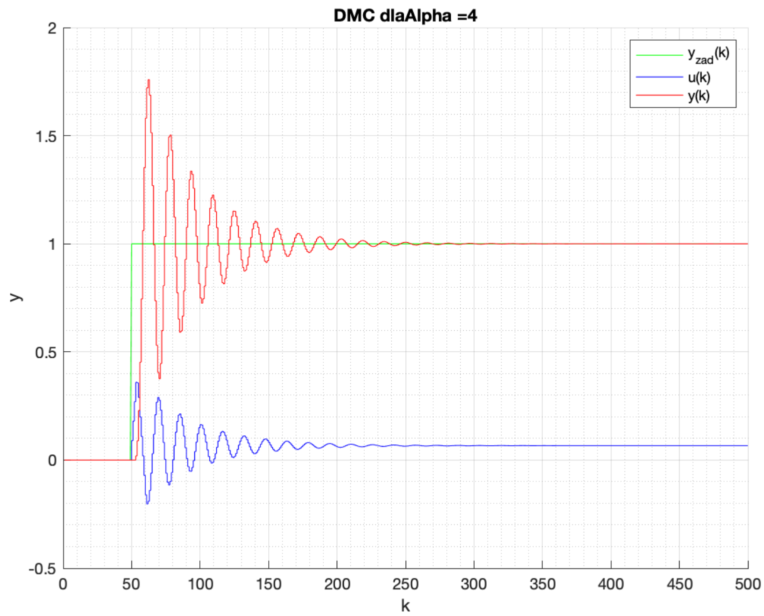
DMC dlaAlpha =6.1
$y_{zad}(k)$
u(k)
y(k)
y
k

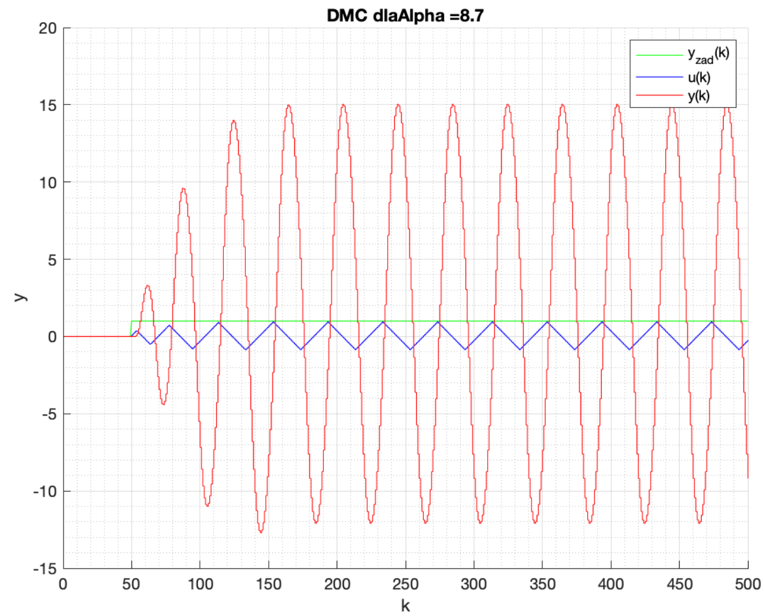


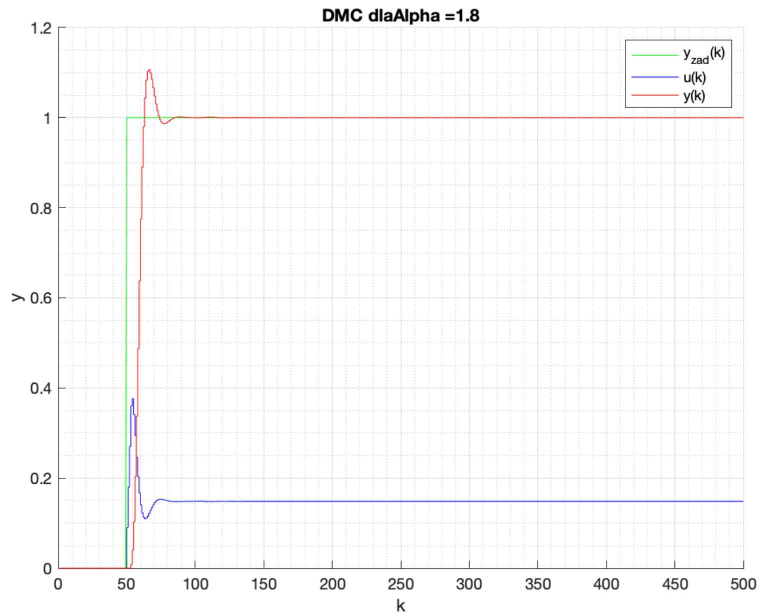
DMC dlaAlpha =2.7
$y_{zad}(k)$
u(k)
y(k)
y
k

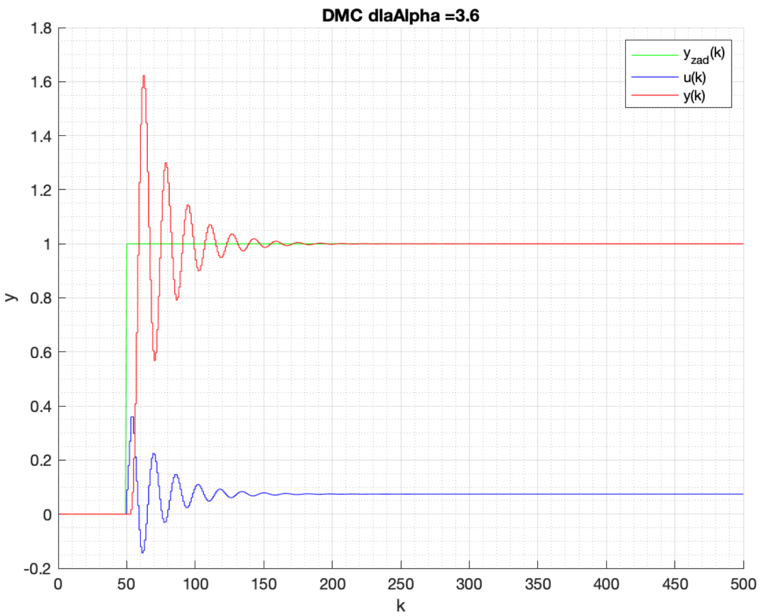

DMC dlaAlpha =1.3
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

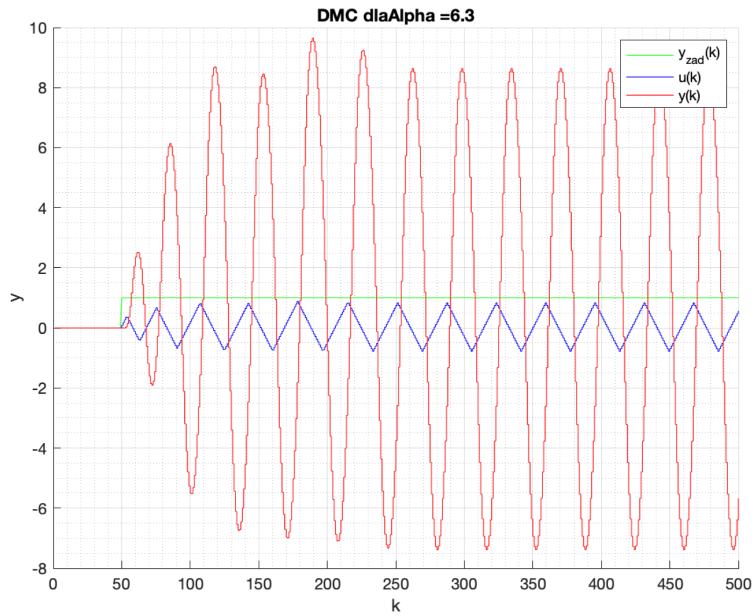

DMC dlaAlpha =4.4
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
-3
-2
-1
0
1
2
3
4
5

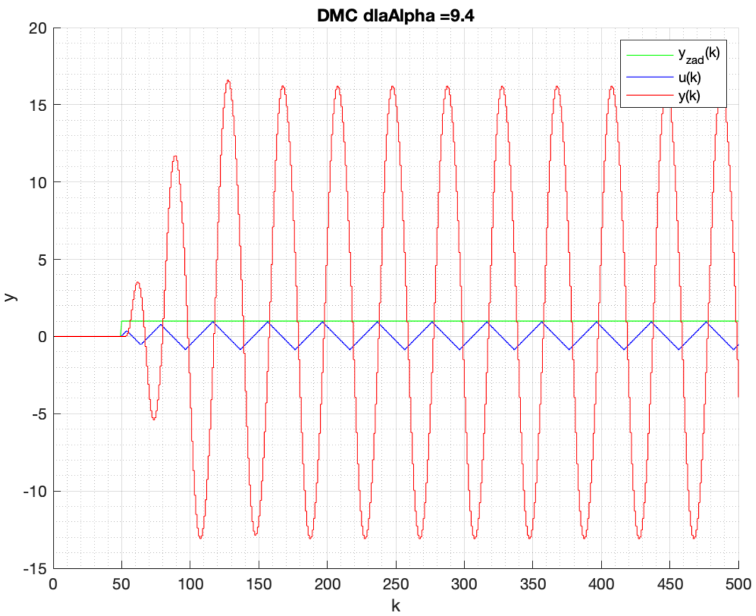

DMC dlaAlpha =4
2
1.5
1
0.5
0
-0.5
y
0
50
100
150
200
250
300
350
400
450
500
k
$y_{zad}(k)$
u(k)
y(k)

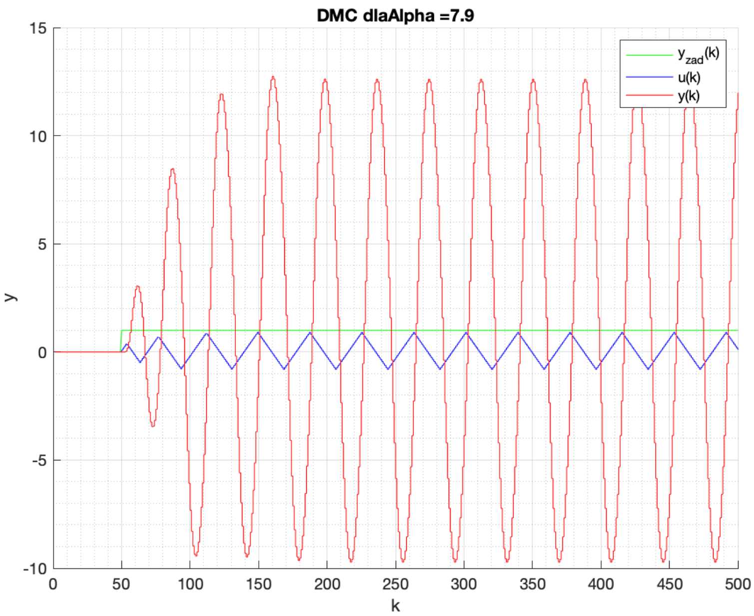

DMC dlaAlpha =8.7
20
15
10
5
0
-5
-10
-15
y
0
50
100
150
200
250
300
350
400
450
500
k
$y_{zad}(k)$
u(k)
y(k)

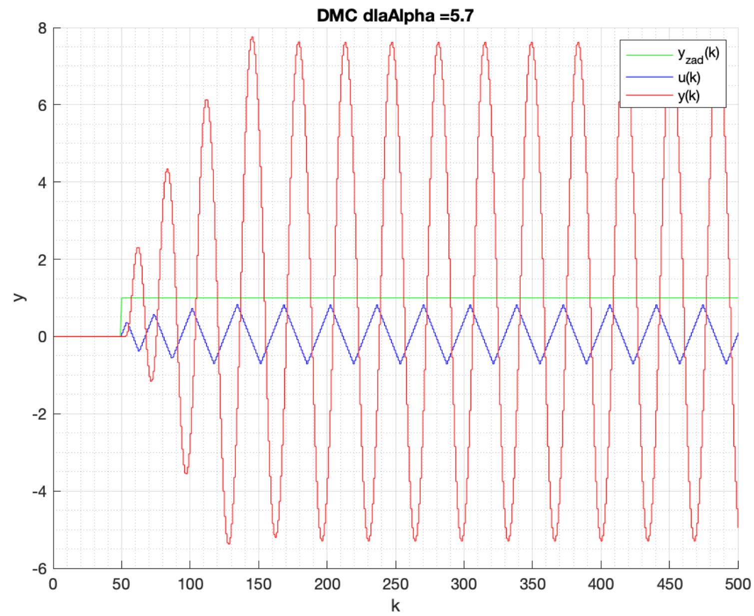

DMC dlaAlpha =1.8
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0.2
0.4
0.6
0.8
1
1.2

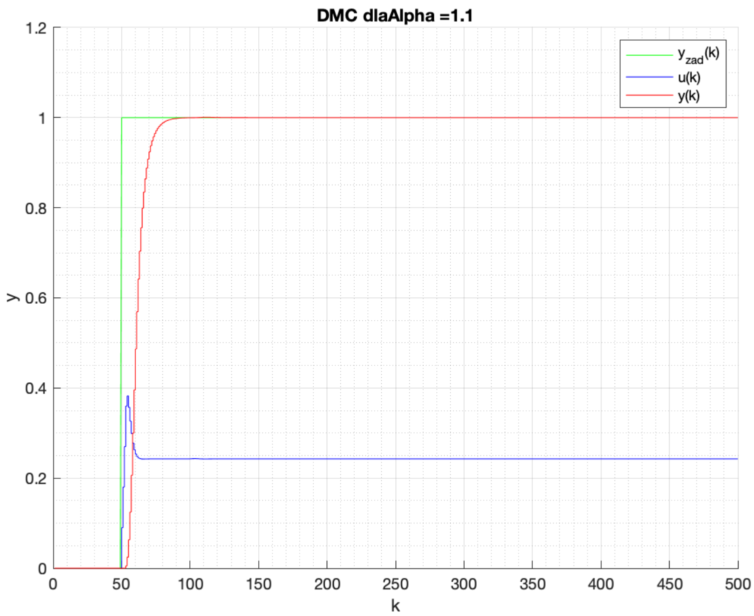

DMC dlaAlpha =3.6
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
-0.2
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8

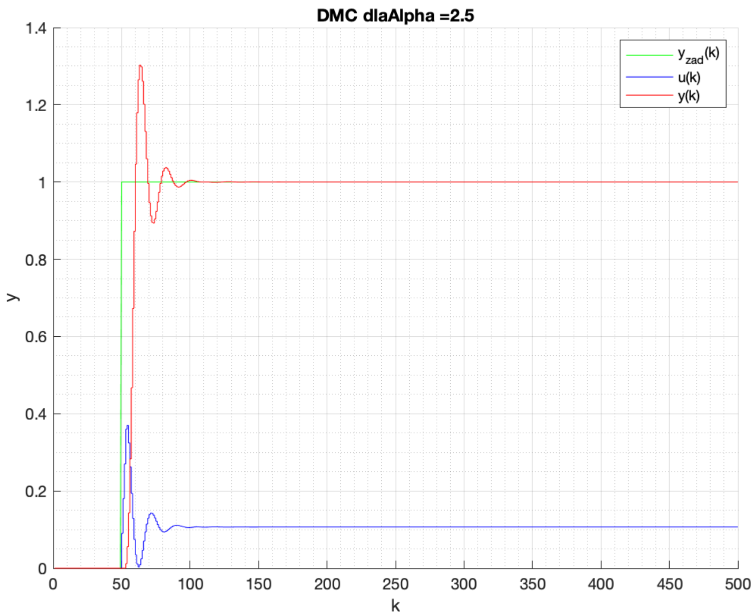

DMC dlaAlpha =6.3
$y_{zad}(k)$
u(k)
y(k)
y
k

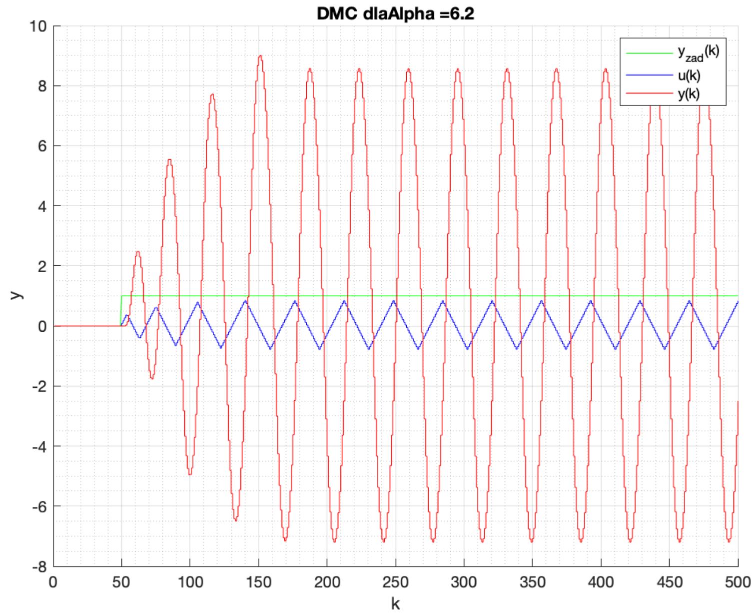

DMC dlaAlpha =9.4
$y_{zad}(k)$
u(k)
y(k)
y
k

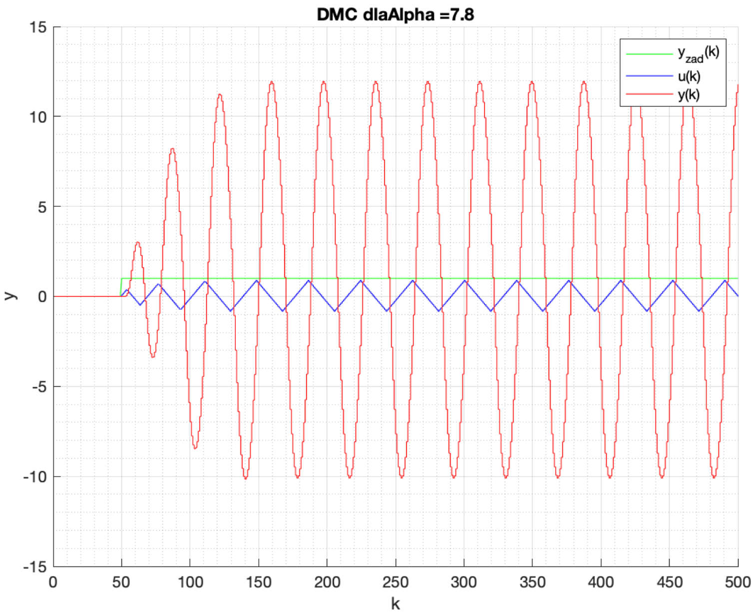

DMC dlaAlpha =7.9
y
k
$y_{zad}(k)$
u(k)
y(k)
15
10
5
0
-5
-10
0
50
100
150
200
250
300
350
400
450
500

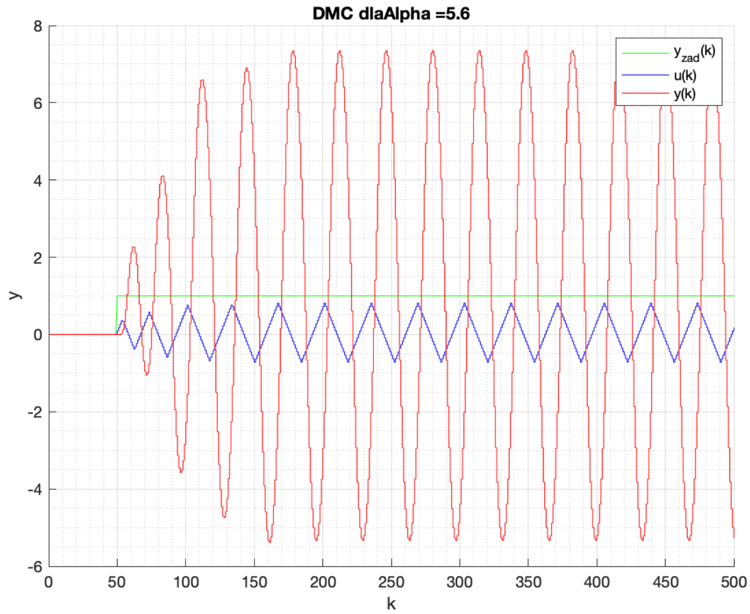

DMC dlaAlpha =5.7
y
k
$y_{zad}(k)$
u(k)
y(k)
8
6
4
2
0
-2
-4
-6
0
50
100
150
200
250
300
350
400
450
500


DMC dlaAlpha =1.1
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

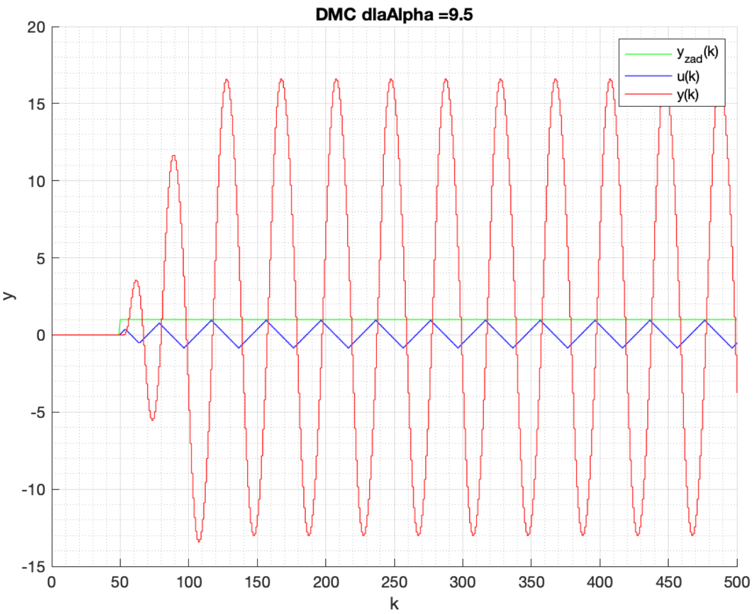

DMC dlaAlpha =2.5
y
k
$y_{zad}(k)$
u(k)
y(k)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
50
100
150
200
250
300
350
400
450
500


DMC dlaAlpha =6.2
$y_{zad}(k)$
u(k)
y(k)
y
k

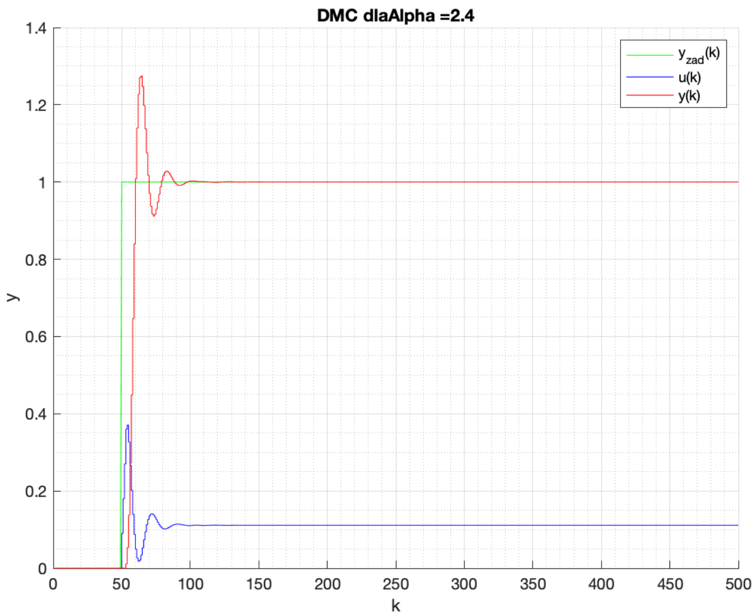

DMC dlaAlpha =7.8
$y_{zad}(k)$
u(k)
y(k)
y
k

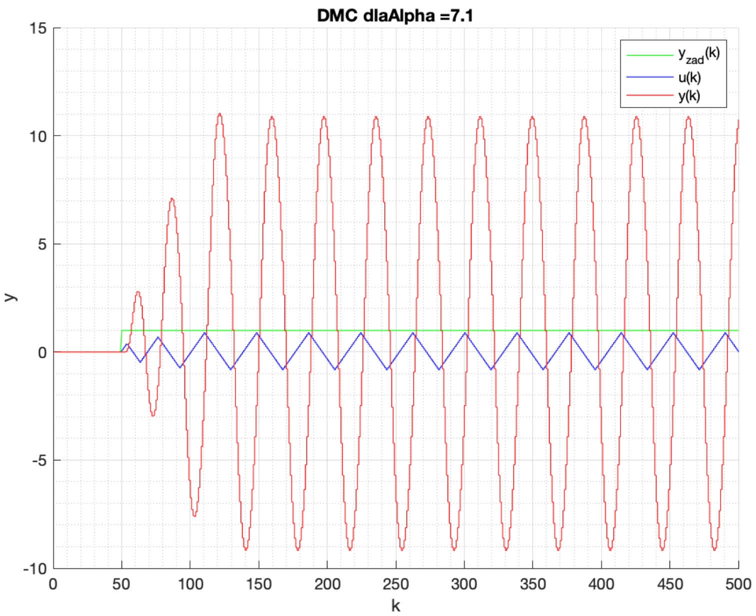


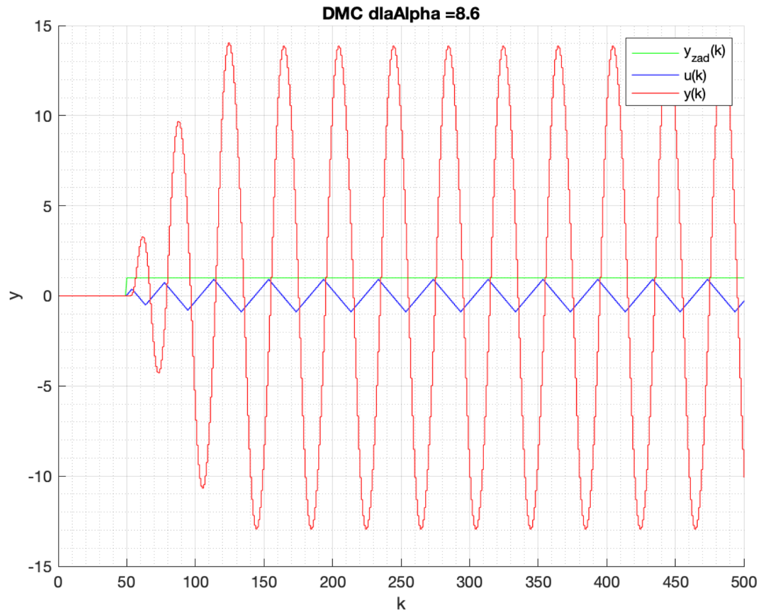
DMC dlaAlpha =5.6
y
k
$y_{zad}(k)$
u(k)
y(k)

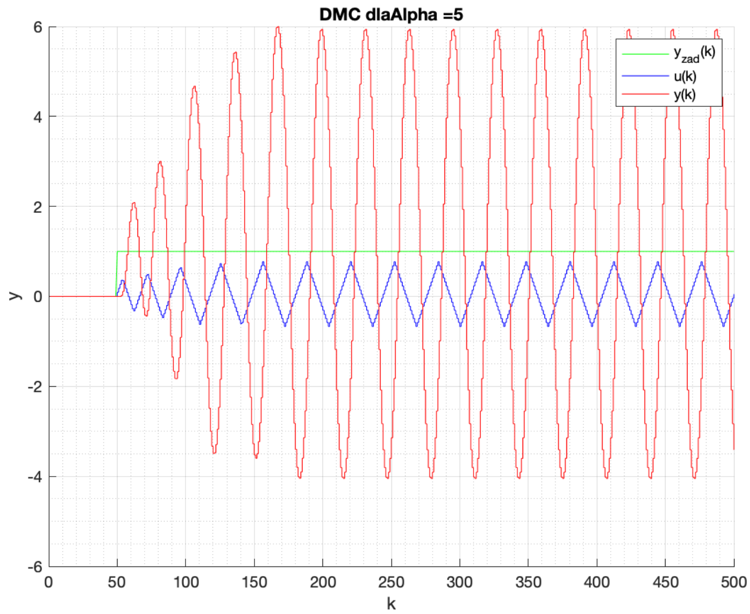


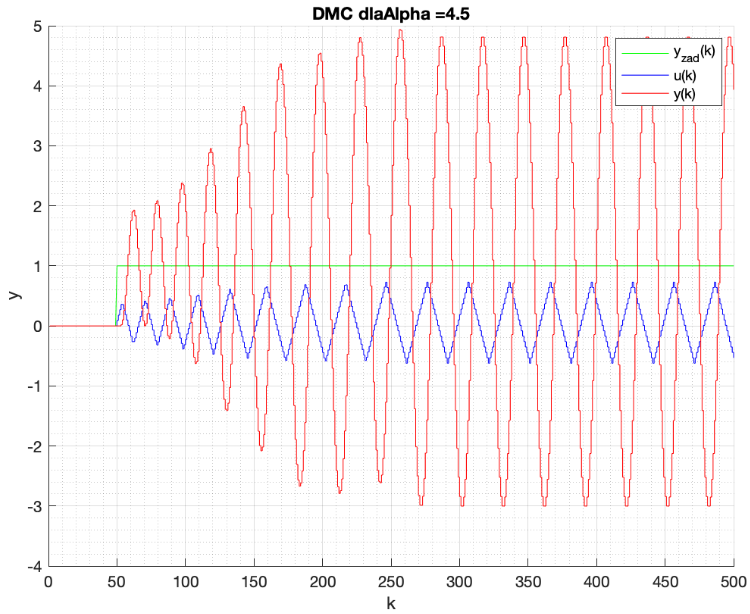
DMC dlaAlpha =9.5
y
k
$y_{zad}(k)$
u(k)
y(k)

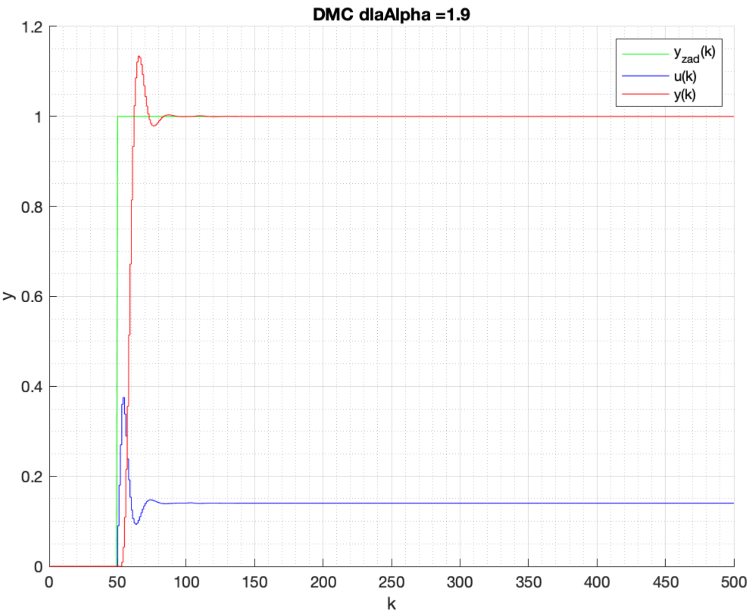

DMC dlaAlpha =2.4
y
k
y_zad(k)
u(k)
y(k)

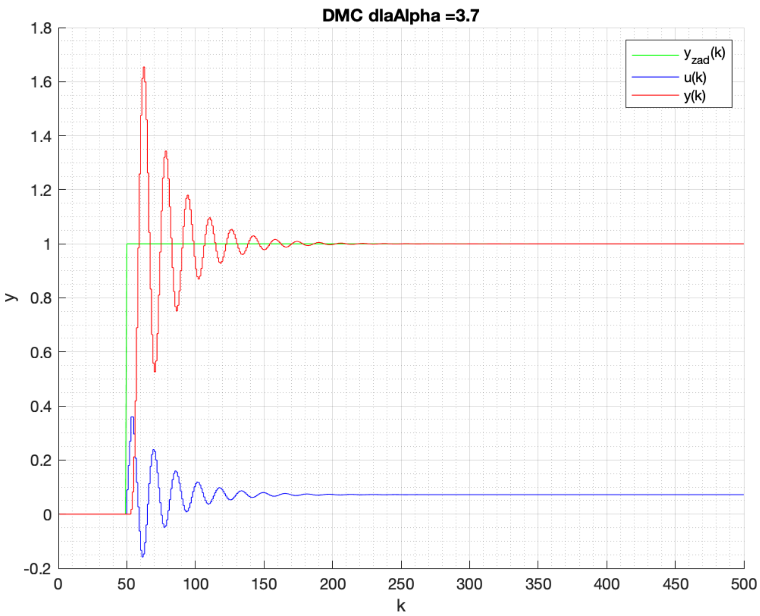

DMC dlaAlpha =7.1
y
k
y_zad(k)
u(k)
y(k)

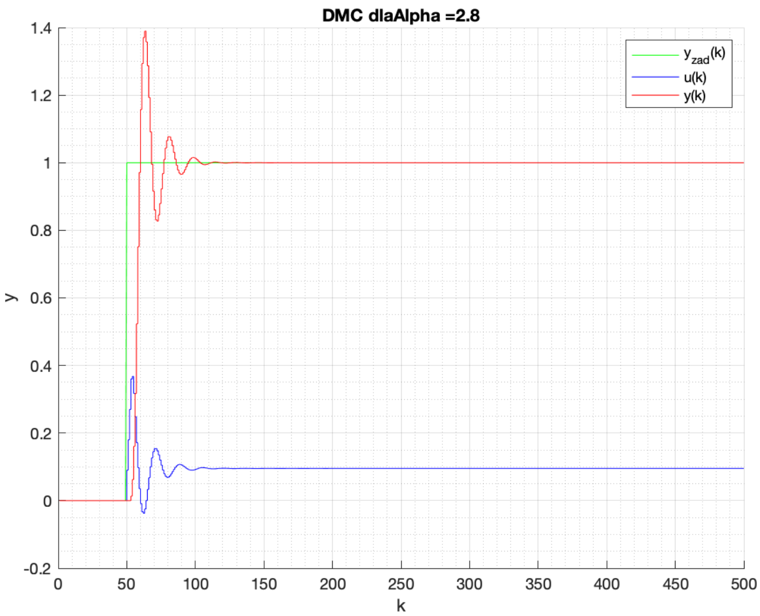

DMC dlaAlpha =8.6
$y_{zad}(k)$
u(k)
y(k)
y
k
15
10
5
0
-5
-10
-15
0
50
100
150
200
250
300
350
400
450
500

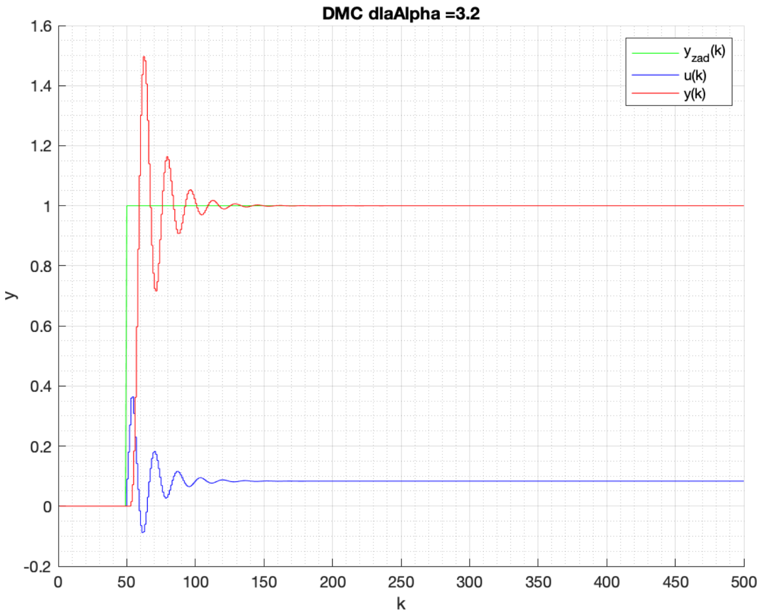

DMC dlaAlpha =5
$y_{zad}(k)$
u(k)
y(k)
y
k
6
4
2
0
-2
-4
-6
0
50
100
150
200
250
300
350
400
450
500

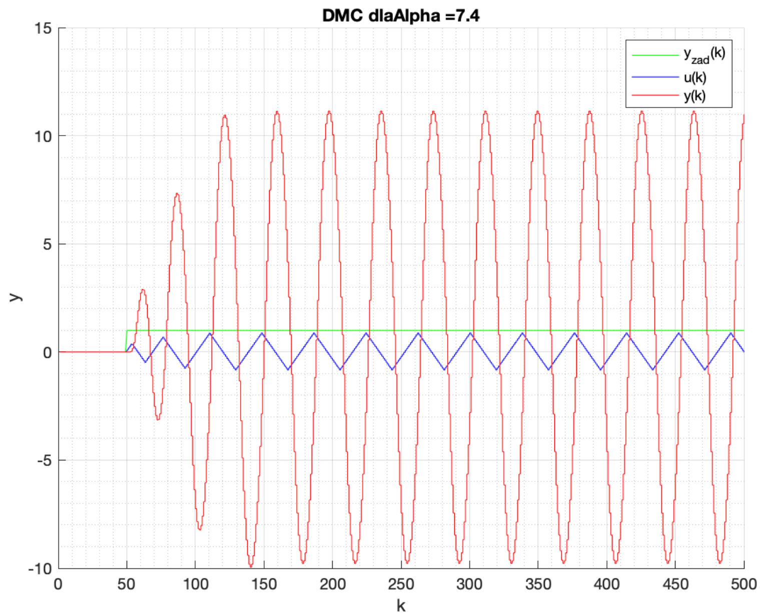

DMC dlaAlpha =4.5
y
k
$y_{zad}(k)$
u(k)
y(k)
5
4
3
2
1
0
-1
-2
-3
-4
0
50
100
150
200
250
300
350
400
450
500

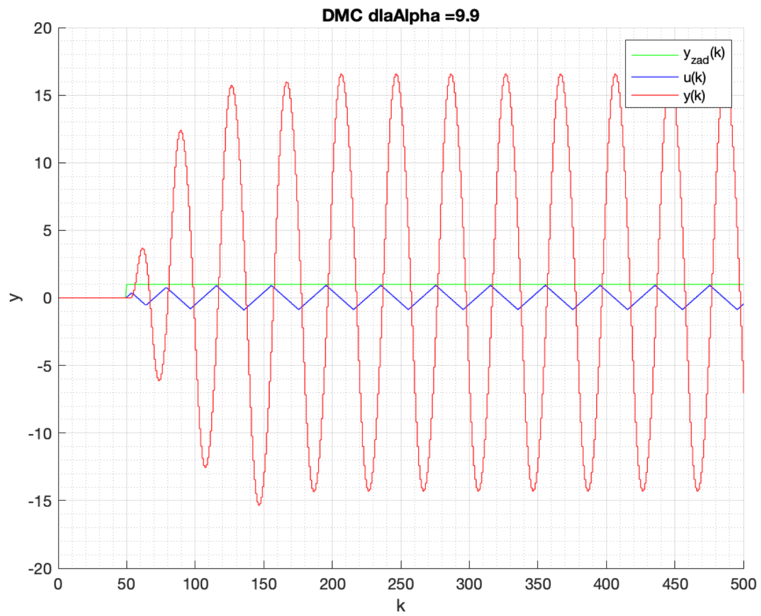

DMC dlaAlpha =1.9
y
k
$y_{zad}(k)$
u(k)
y(k)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

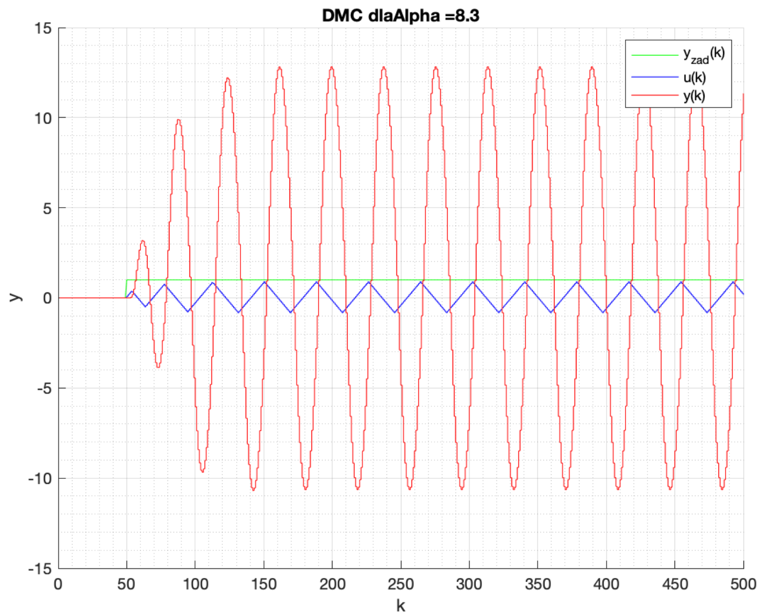

DMC dlaAlpha =3.7
y
k
$y_{zad}(k)$
u(k)
y(k)
0
50
100
150
200
250
300
350
400
450
500
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2

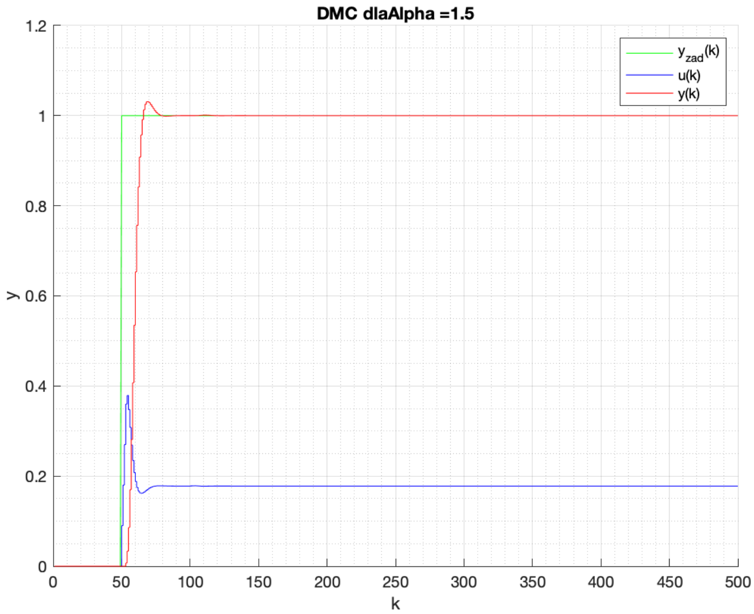

DMC dlaAlpha =2.8
y
k
$y_{zad}(k)$
u(k)
y(k)
0
50
100
150
200
250
300
350
400
450
500
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2

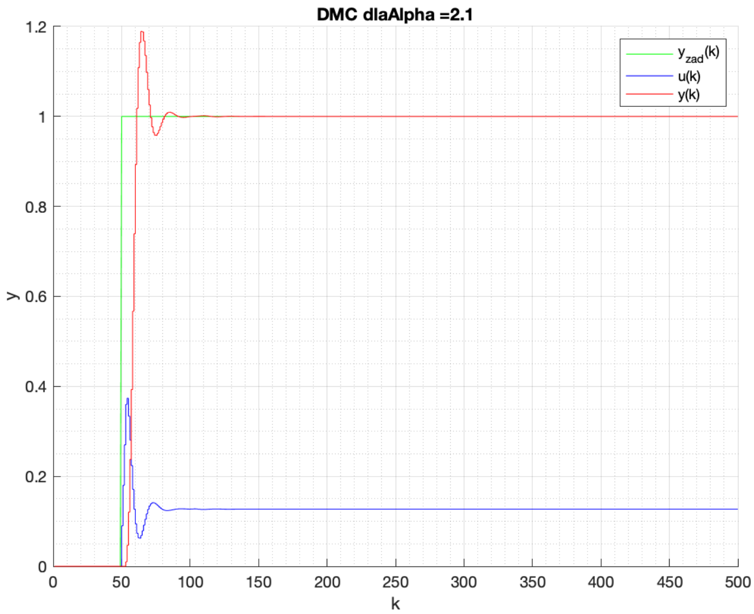

DMC dlaAlpha =3.2
y
k
$y_{zad}(k)$
u(k)
y(k)

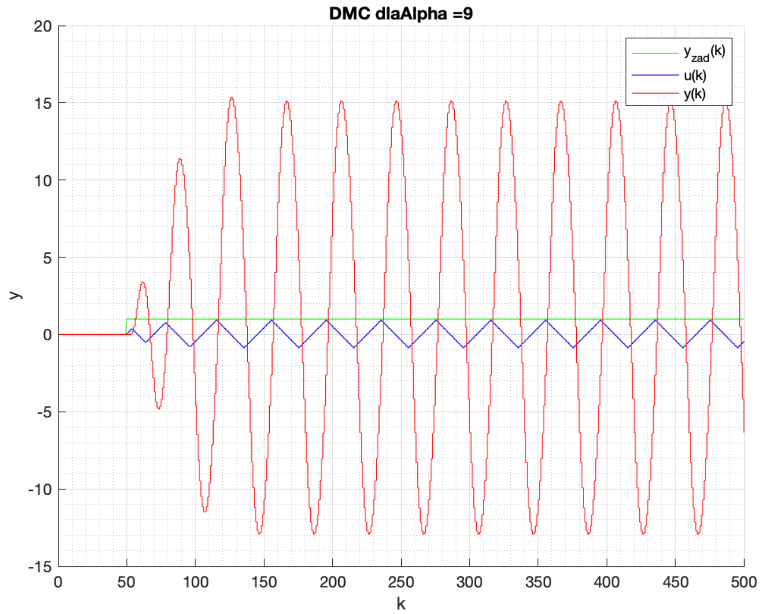

DMC dlaAlpha =7.4
y
k
$y_{zad}(k)$
u(k)
y(k)

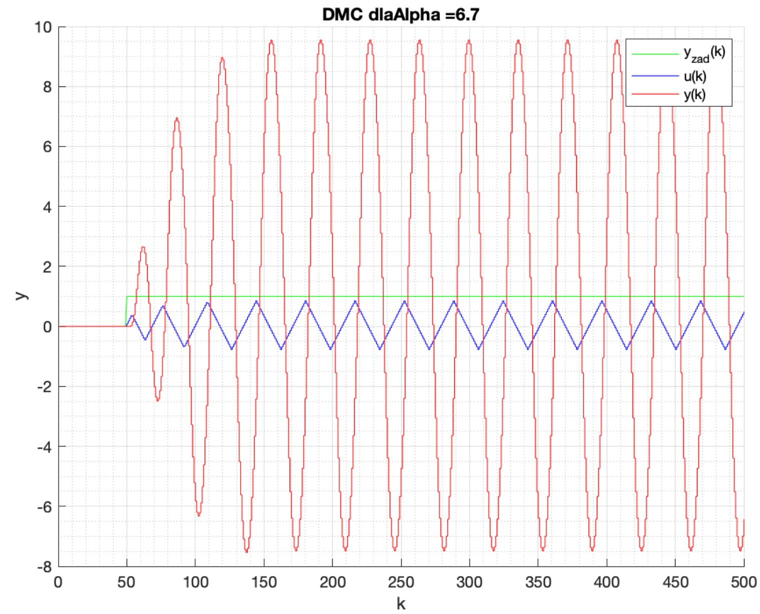

DMC dlaAlpha =9.9
y
k
$y_{zad}(k)$
u(k)
y(k)

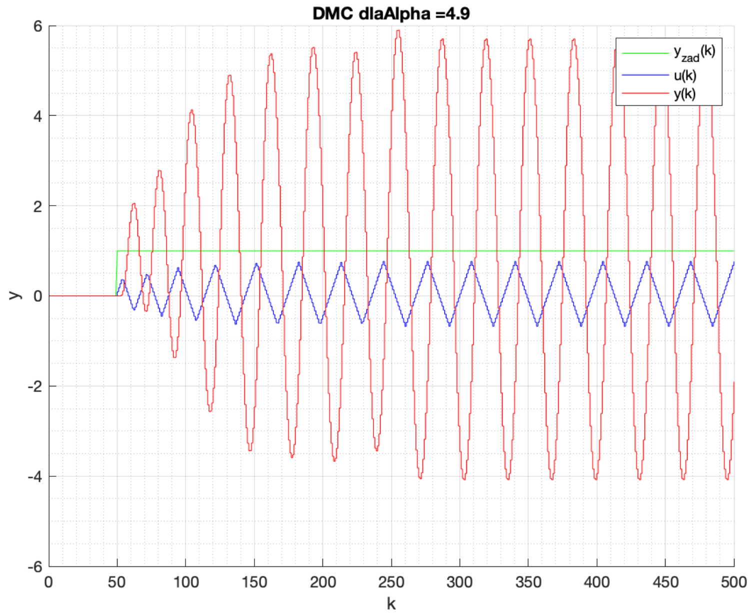

DMC dlaAlpha =8.3
y
k
$y_{zad}(k)$
u(k)
y(k)

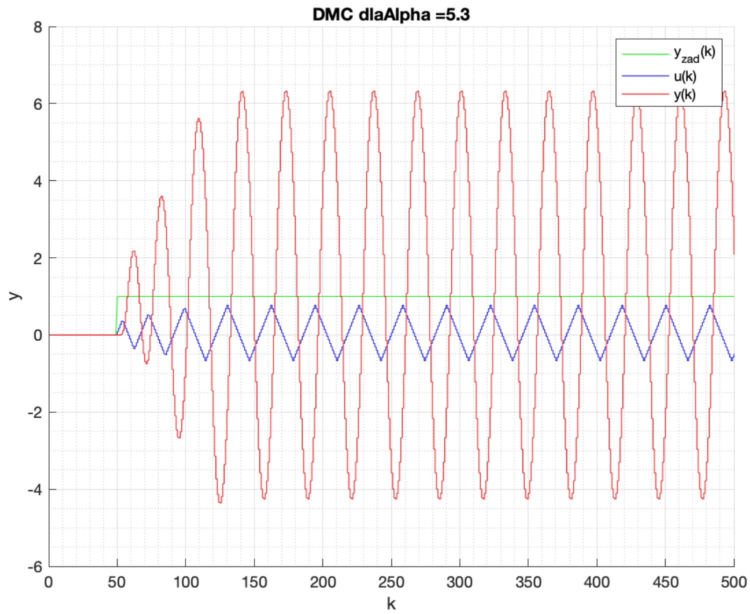

DMC dlaAlpha =1.5
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500

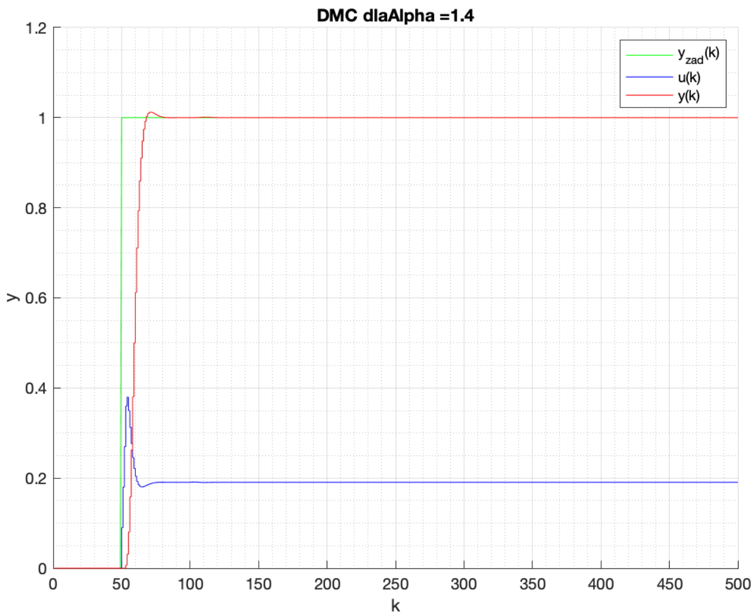

DMC dlaAlpha =2.1
$y_{zad}(k)$
u(k)
y(k)
y
k
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300
350
400
450
500


DMC dlaAlpha =9
y
k
y_zad(k)
u(k)
y(k)
20
15
10
5
0
-5
-10
-15
0
50
100
150
200
250
300
350
400
450
500

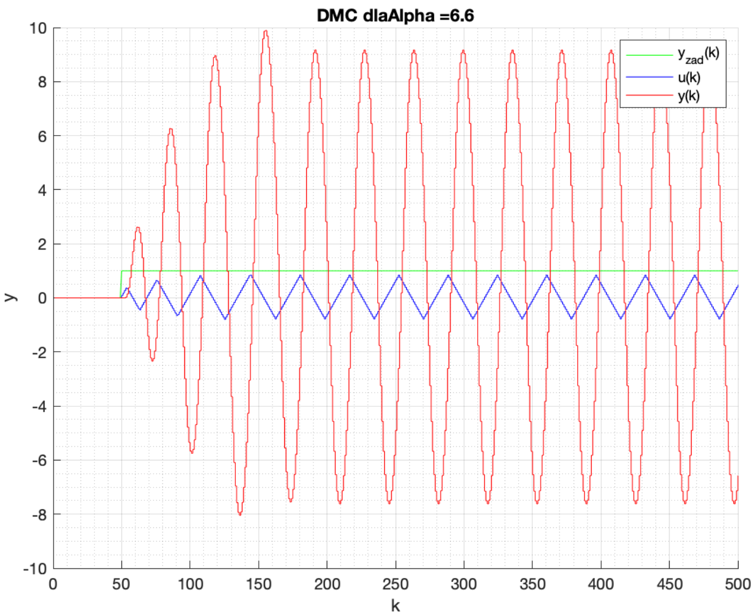

DMC dlaAlpha =6.7
y
k
y_zad(k)
u(k)
y(k)
10
8
6
4
2
0
-2
-4
-6
-8
0
50
100
150
200
250
300
350
400
450
500


DMC dlaAlpha =4.9
y
k
$y_{zad}(k)$
u(k)
y(k)

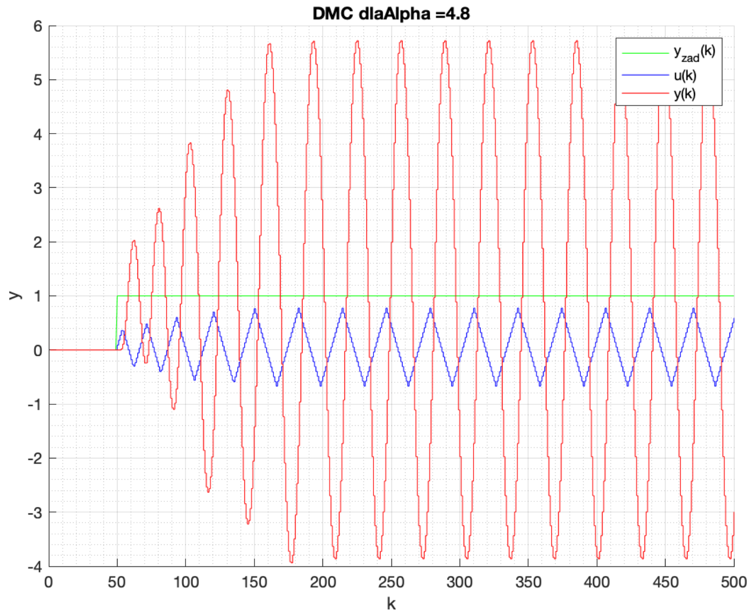

DMC dlaAlpha =5.3
y
k
$y_{zad}(k)$
u(k)
y(k)

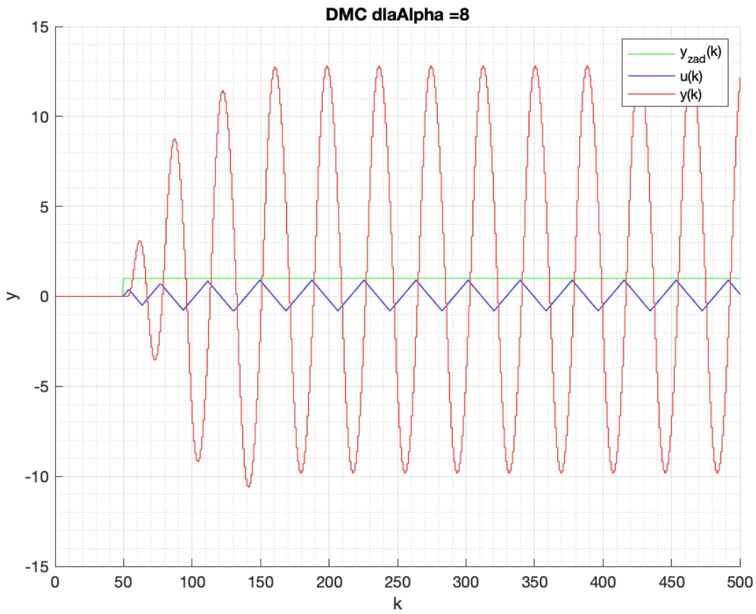


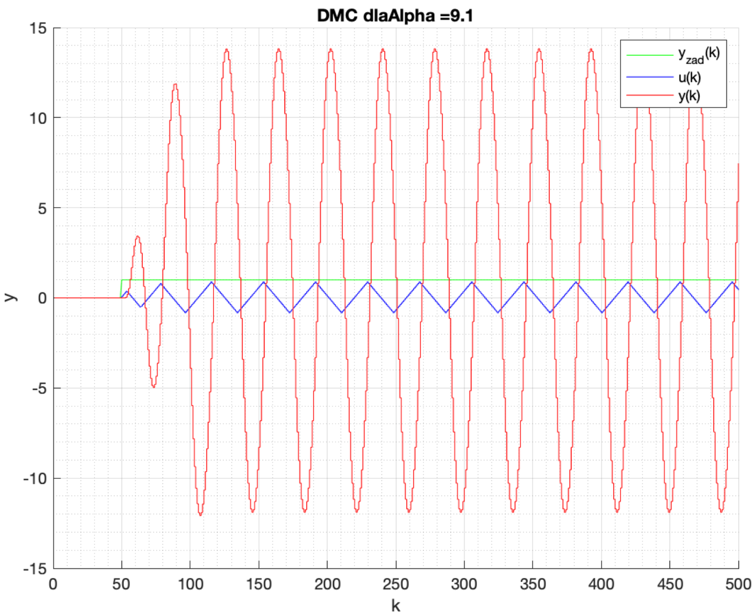
DMC dlaAlpha =1.4
$y_{zad}(k)$
u(k)
y(k)
y
k

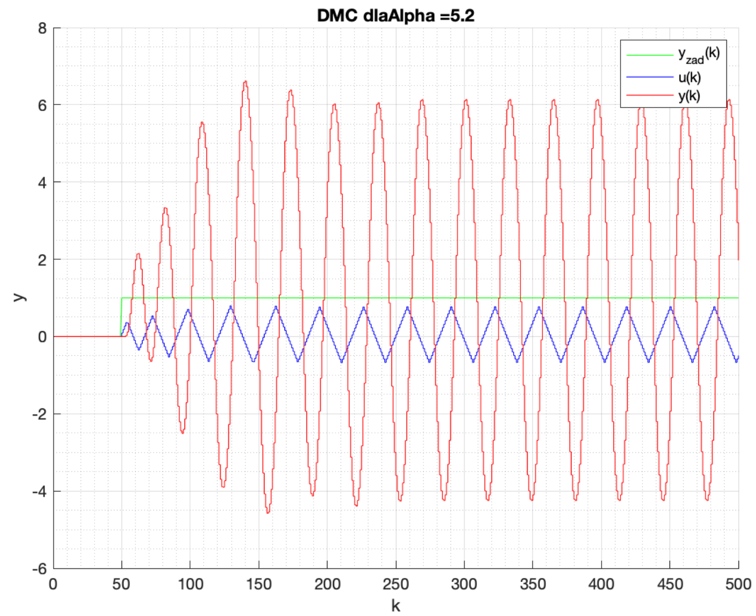


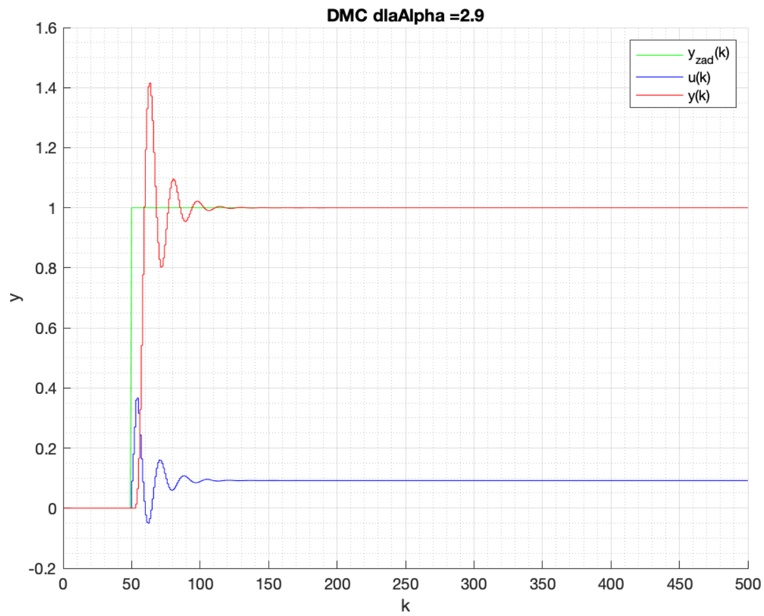
DMC dlaAlpha =6.6
$y_{zad}(k)$
u(k)
y(k)
y
k

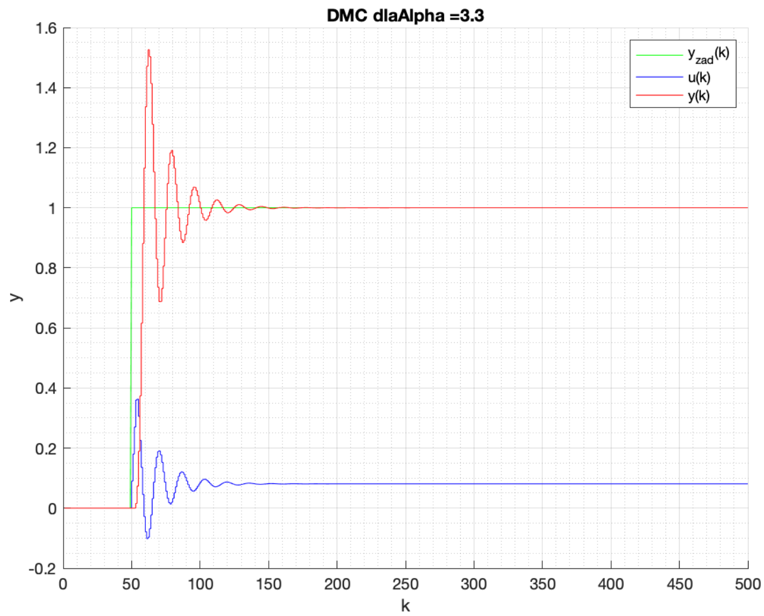

DMC dlaAlpha =4.8
$y_{zad}(k)$
u(k)
y(k)
y
k
6
5
4
3
2
1
0
-1
-2
-3
-4
0
50
100
150
200
250
300
350
400
450
500

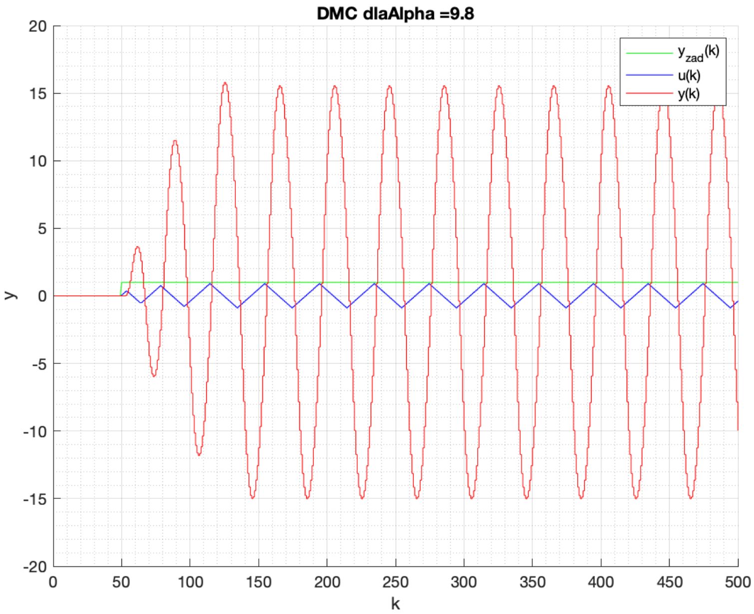

DMC dlaAlpha =8
$y_{zad}(k)$
u(k)
y(k)
y
k
15
10
5
0
-5
-10
-15
0
50
100
150
200
250
300
350
400
450
500

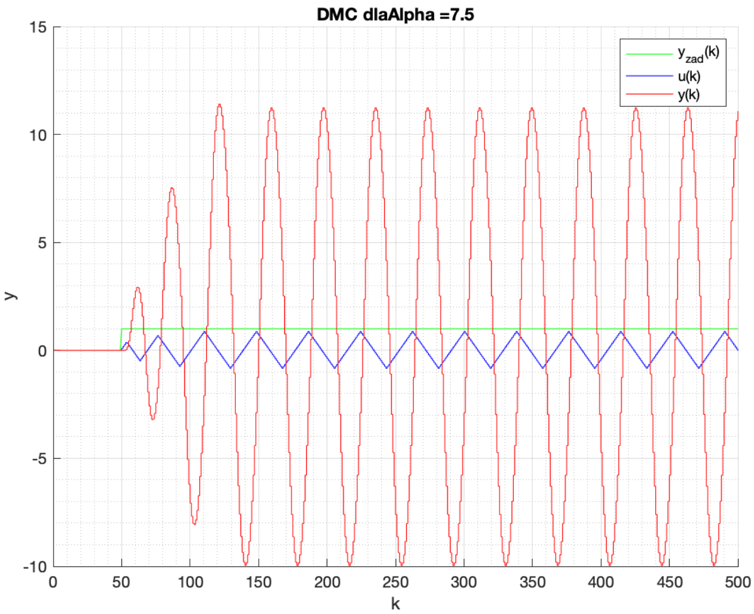

DMC dlaAlpha =9.1
$y_{zad}(k)$
u(k)
y(k)
y
k

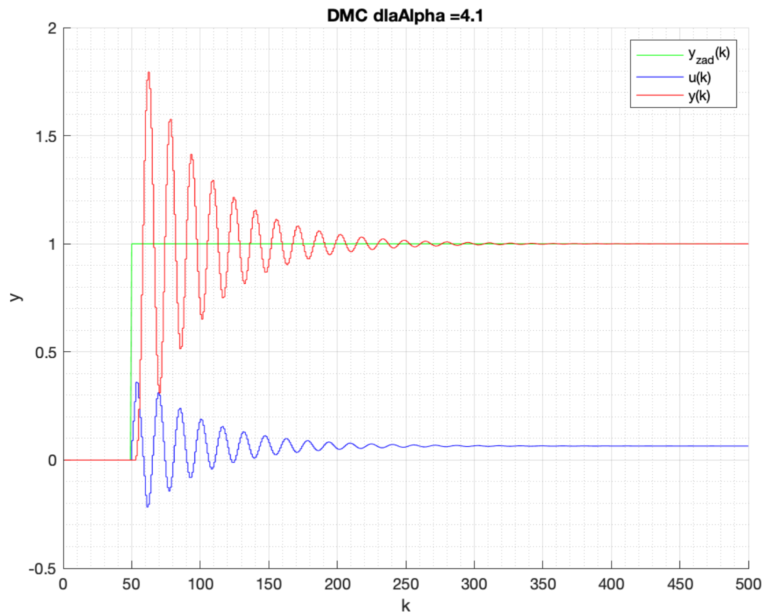

DMC dlaAlpha =5.2
$y_{zad}(k)$
u(k)
y(k)
y
k

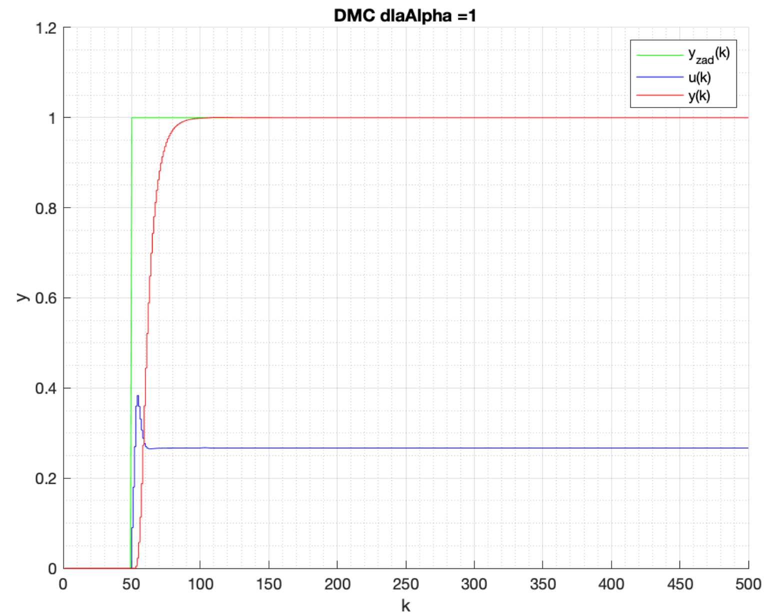

DMC dlaAlpha =2.9
$y_{zad}(k)$
u(k)
y(k)
y
k
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
50
100
150
200
250
300
350
400
450
500

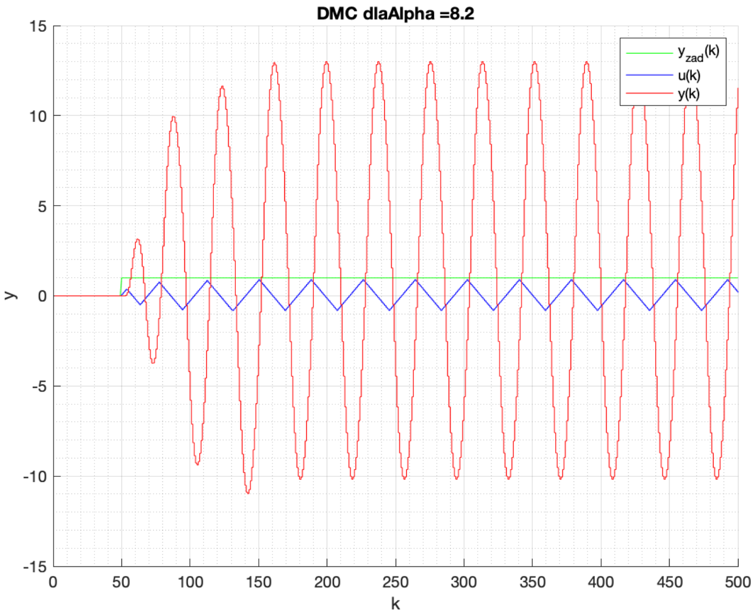

DMC dlaAlpha =3.3
$y_{zad}(k)$
u(k)
y(k)
y
k
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
50
100
150
200
250
300
350
400
450
500


DMC dlaAlpha =9.8
y
k
$y_{zad}(k)$
u(k)
y(k)

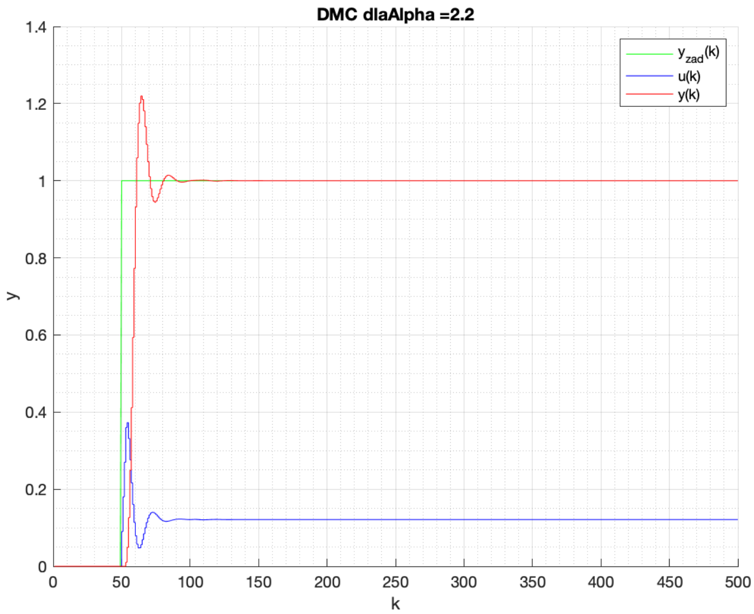

DMC dlaAlpha =7.5
y
k
$y_{zad}(k)$
u(k)
y(k)


DMC dlaAlpha =4.1
$y_{zad}(k)$
u(k)
y(k)
y
k
2
1.5
1
0.5
0
-0.5
0
50
100
150
200
250
300
350
400
450
500

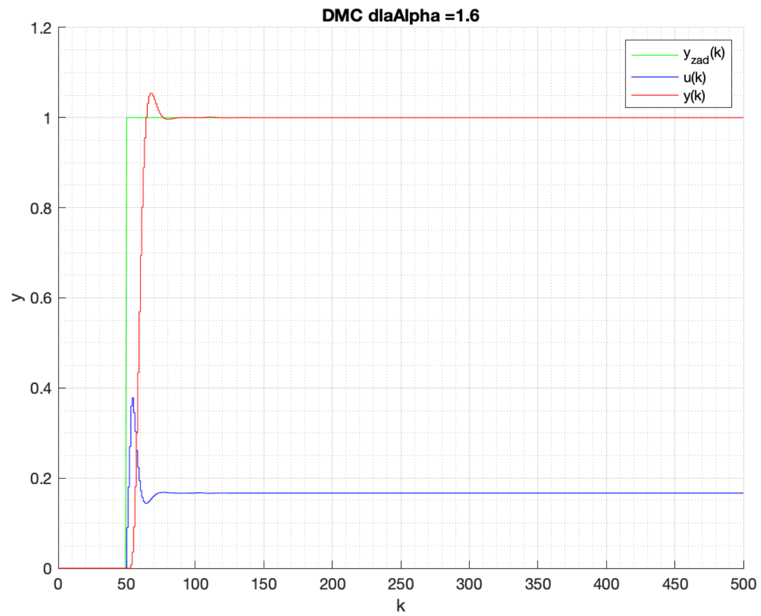

DMC dlaAlpha =1
$y_{zad}(k)$
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

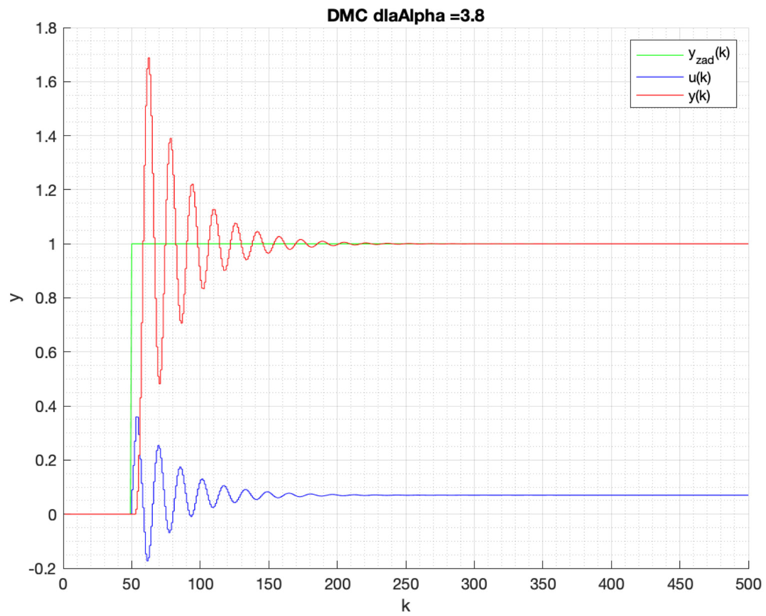


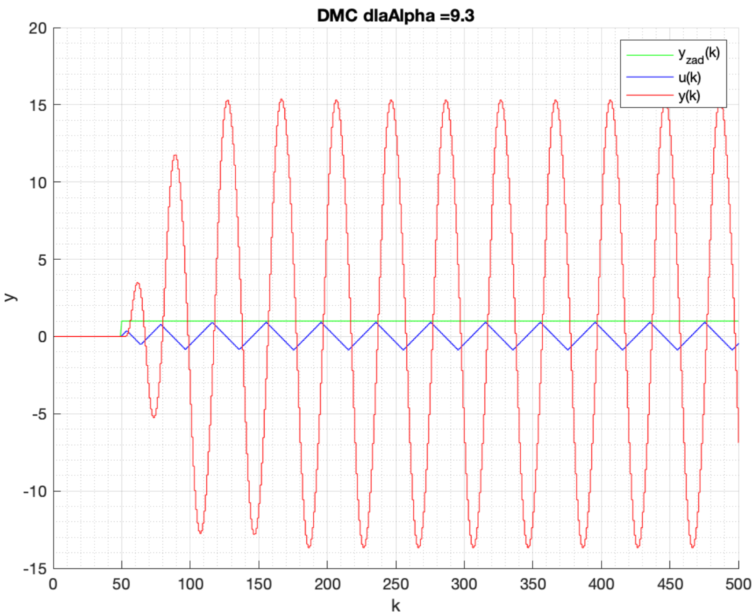
DMC dlaAlpha =8.2
$y_{zad}(k)$
u(k)
y(k)
y
k

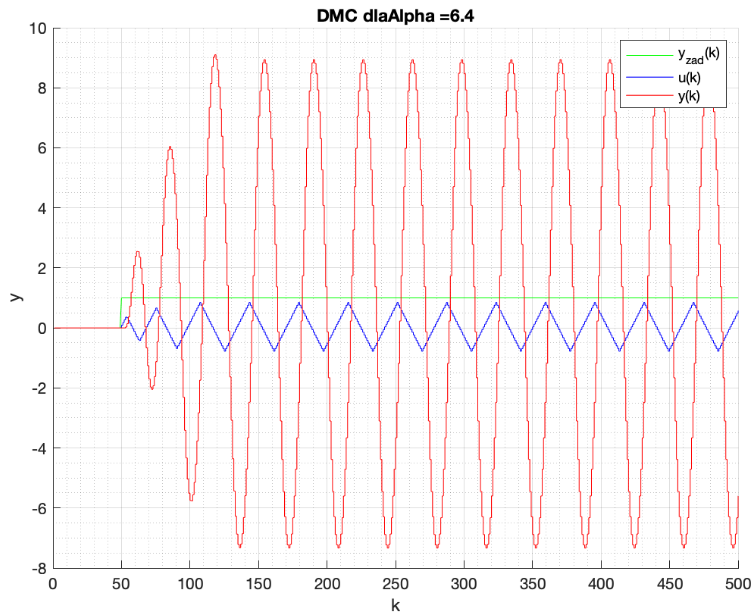


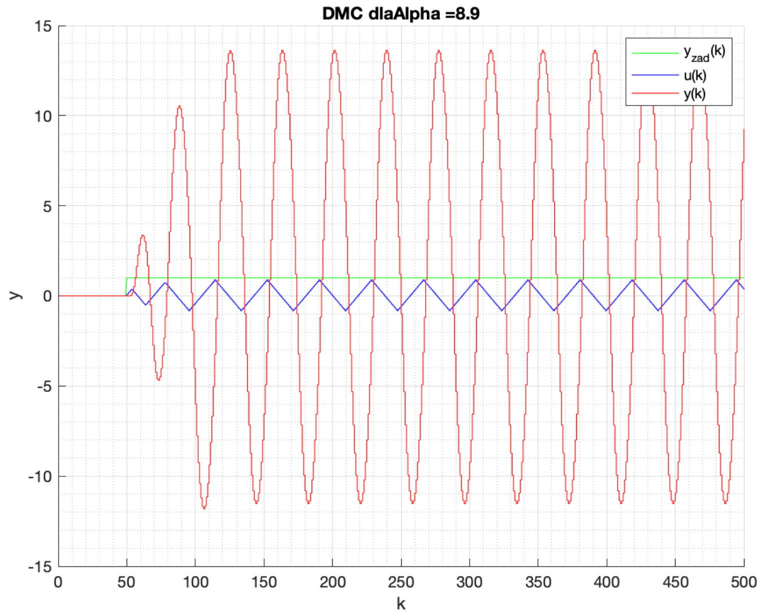
DMC dlaAlpha =2.2
$y_{zad}(k)$
u(k)
y(k)
y
k

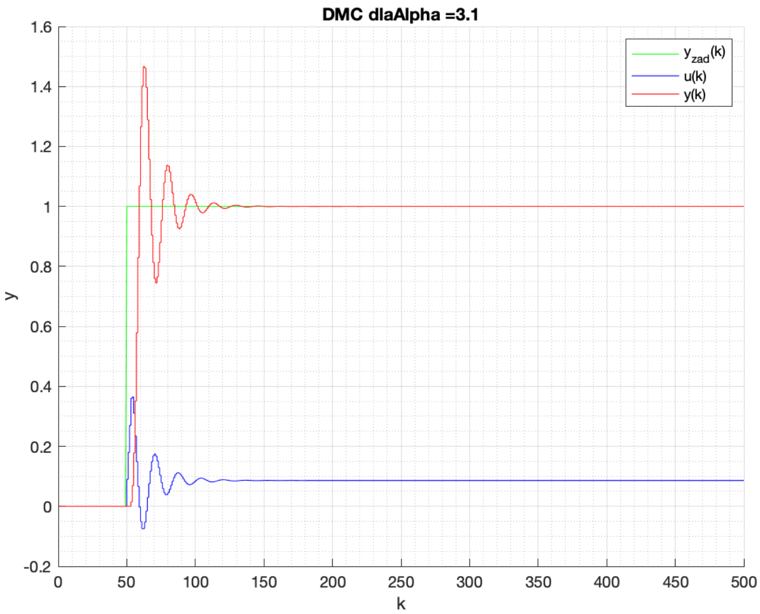

DMC dlaAlpha =1.6
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
0
0.2
0.4
0.6
0.8
1
1.2

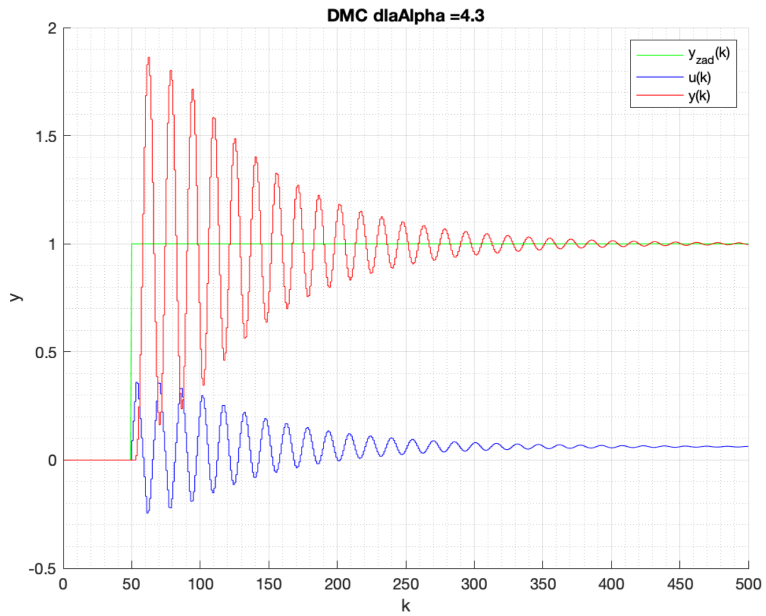

DMC dlaAlpha =3.8
$y_{zad}(k)$
u(k)
y(k)
y
k
0
50
100
150
200
250
300
350
400
450
500
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8


DMC dlaAlpha =9.3
y
k
$y_{zad}(k)$
u(k)
y(k)

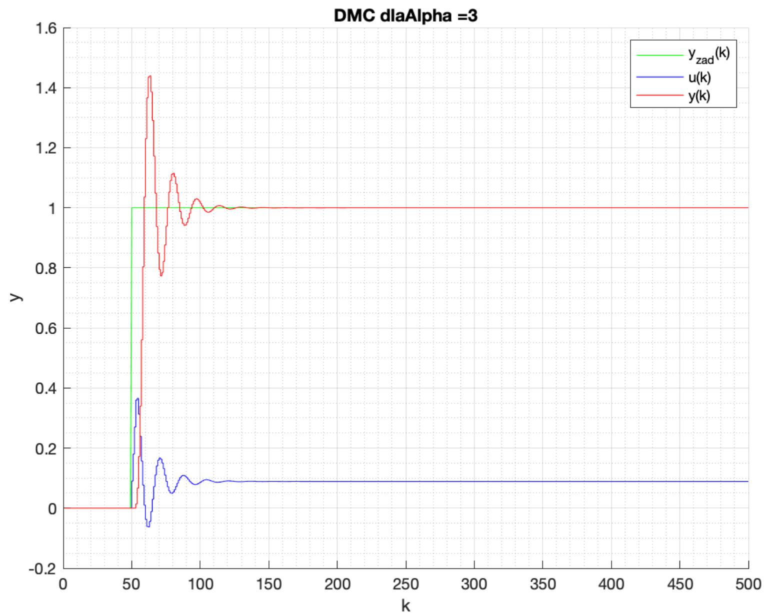

DMC dlaAlpha =6.4
y
k
$y_{zad}(k)$
u(k)
y(k)


DMC dlaAlpha =8.9
15
10
5
0
-5
-10
-15
y
0
50
100
150
200
250
300
350
400
450
500
k
y_{zad}(k)
u(k)
y(k)

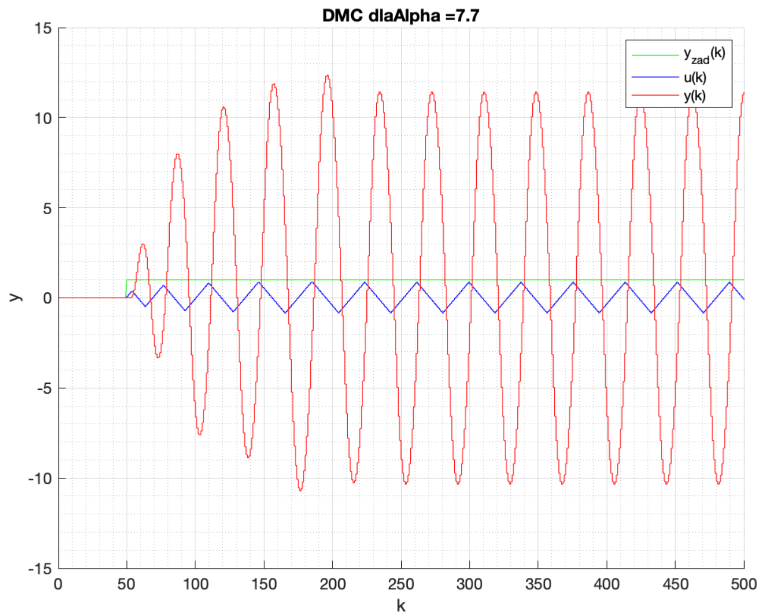

DMC dlaAlpha =3.1
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
y
0
50
100
150
200
250
300
350
400
450
500
k
y_{zad}(k)
u(k)
y(k)

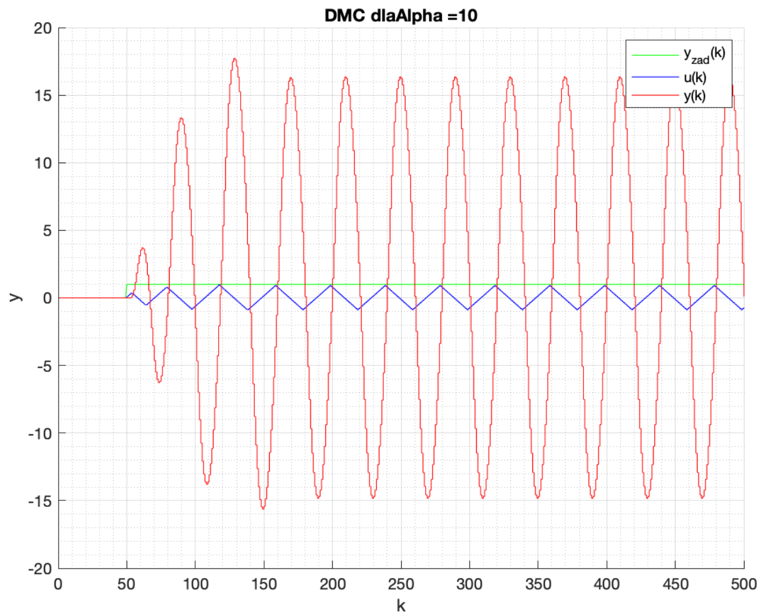


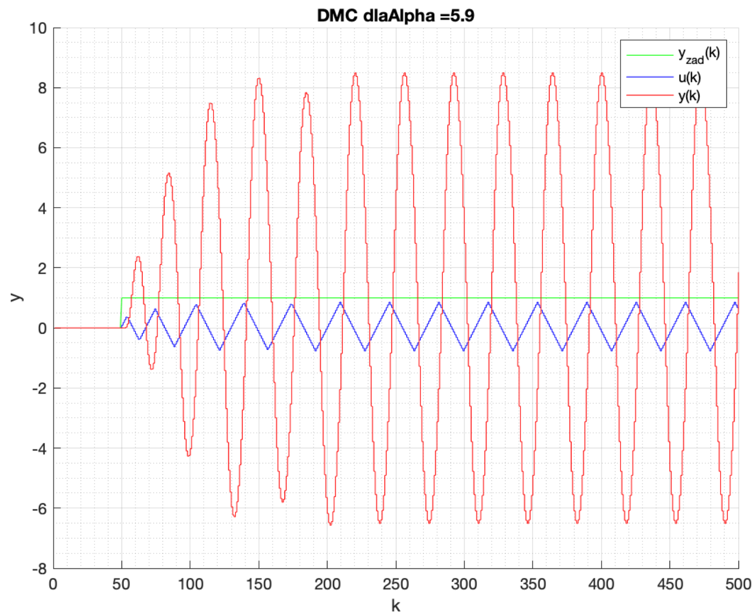
DMC dlaAlpha =4.3
$y_{zad}(k)$
u(k)
y(k)
y
k
2
1.5
1
0.5
0
-0.5
0
50
100
150
200
250
300
350
400
450
500

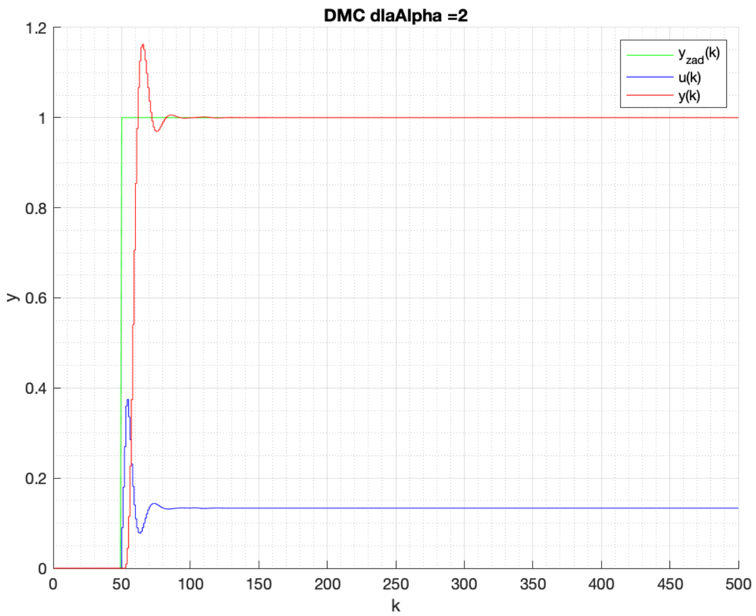


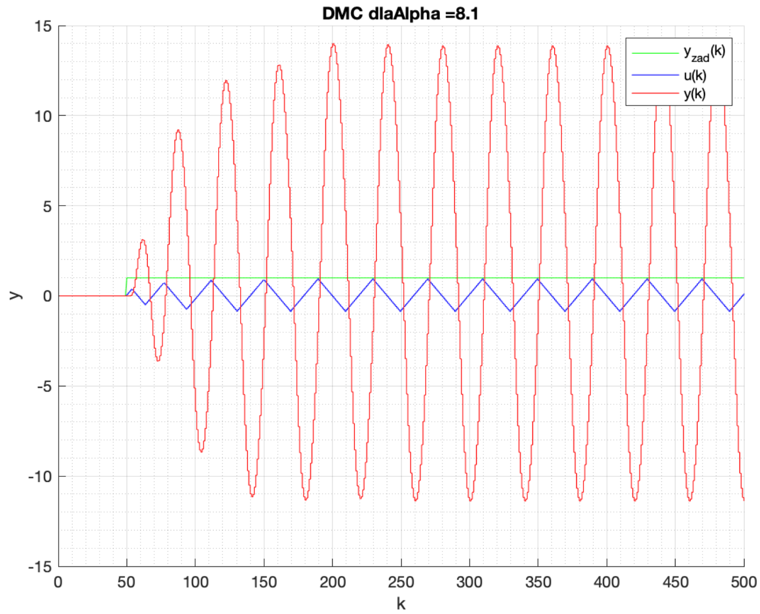
DMC dlaAlpha =3
$y_{zad}(k)$
u(k)
y(k)
y
k
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
50
100
150
200
250
300
350
400
450
500

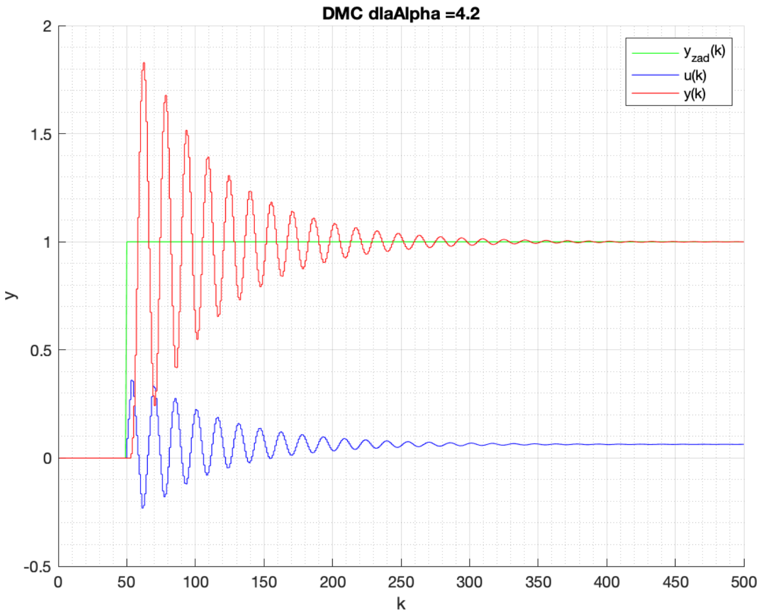

DMC dlaAlpha =7.7
$y_{zad}(k)$
u(k)
y(k)
y
k

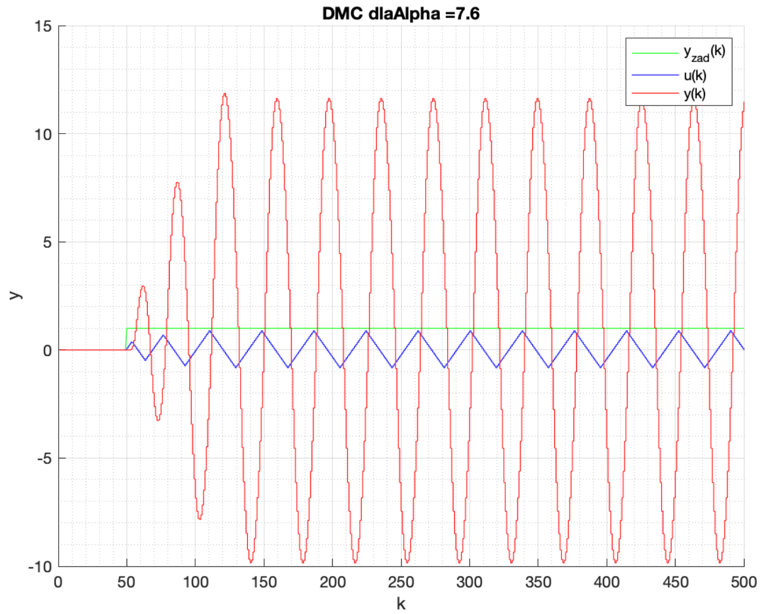

DMC dlaAlpha =10
$y_{zad}(k)$
u(k)
y(k)
y
k

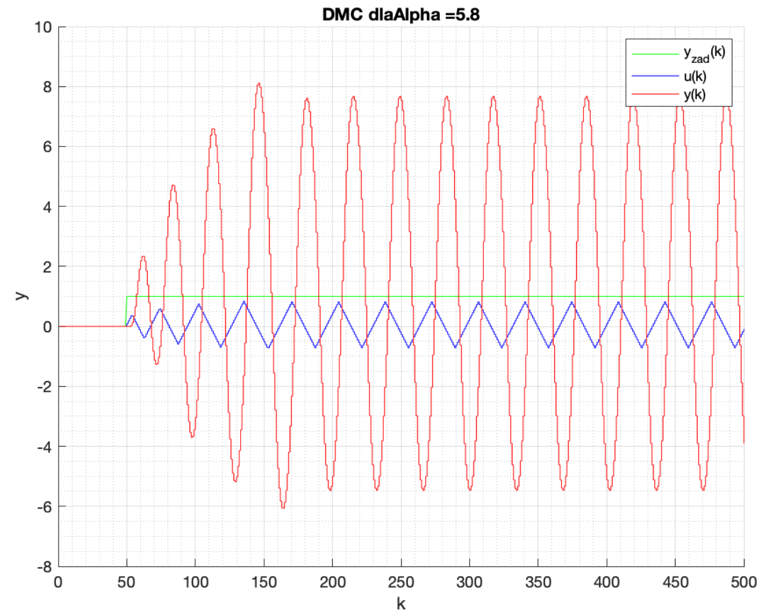

DMC dlaAlpha =5.9
$y_{zad}(k)$
u(k)
y(k)
y
k
10
8
6
4
2
0
-2
-4
-6
-8
0
50
100
150
200
250
300
350
400
450
500

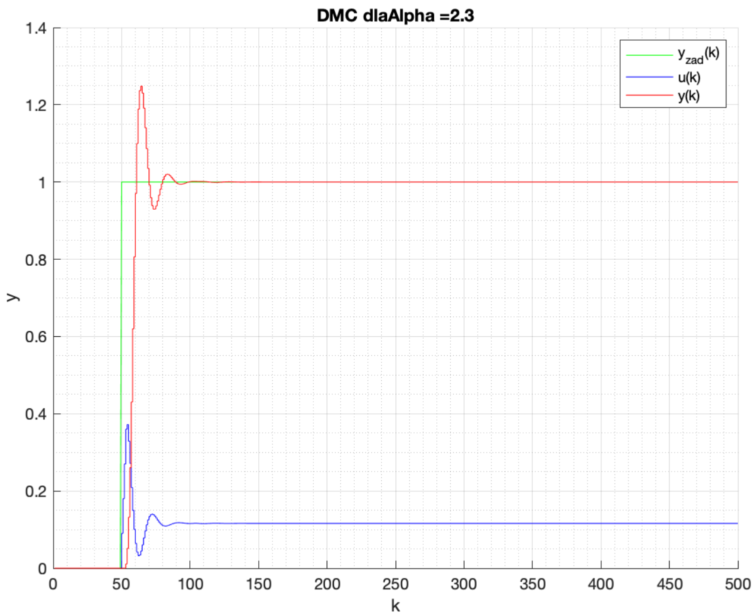

DMC dlaAlpha =2
$y_{zad}(k)$
u(k)
y(k)
y
k
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
500

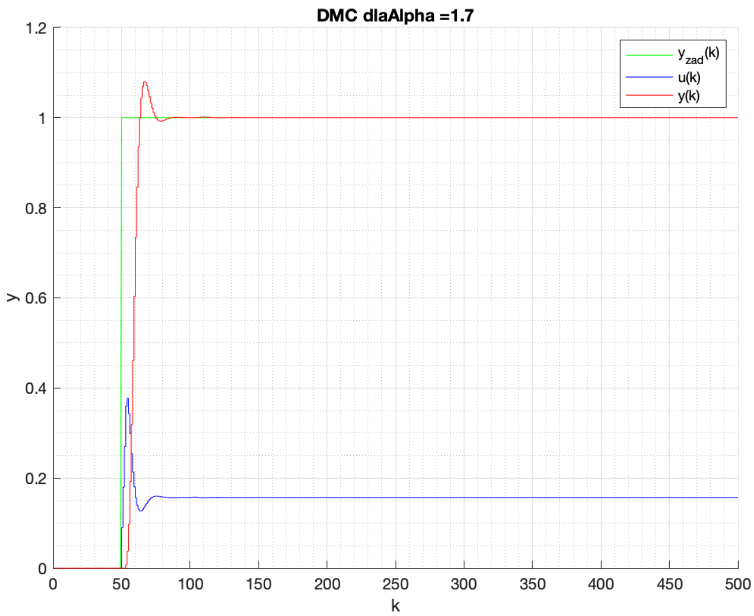

DMC dlaAlpha =8.1
y
k
y_zad(k)
u(k)
y(k)
15
10
5
0
-5
-10
-15
0
50
100
150
200
250
300
350
400
450
500

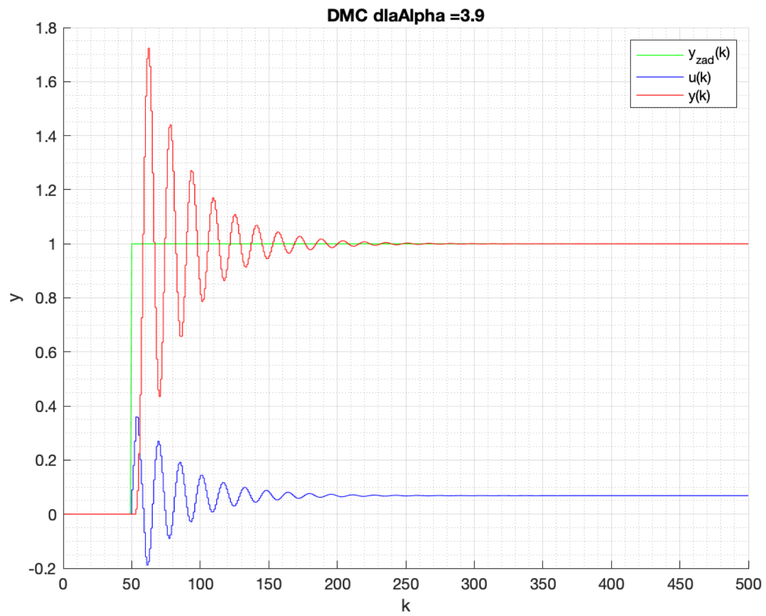

DMC dlaAlpha =4.2
y
k
y_zad(k)
u(k)
y(k)
2
1.5
1
0.5
0
-0.5
0
50
100
150
200
250
300
350
400
450
500

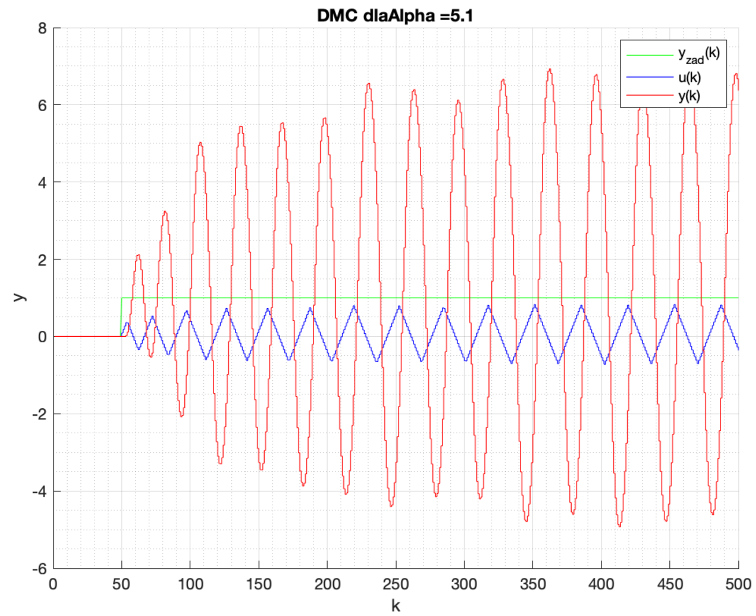

DMC dlaAlpha =7.6
y
k
y_{zad}(k)
u(k)
y(k)

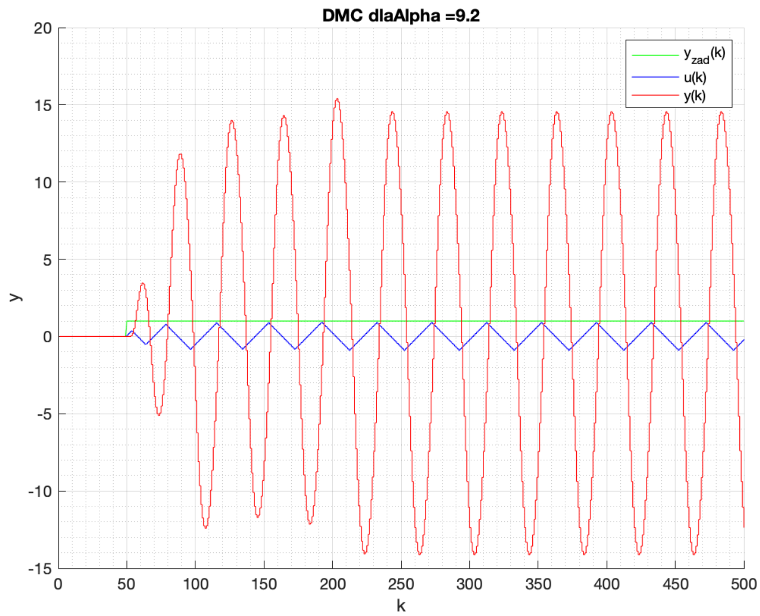

DMC dlaAlpha =5.8
y
k
y_{zad}(k)
u(k)
y(k)

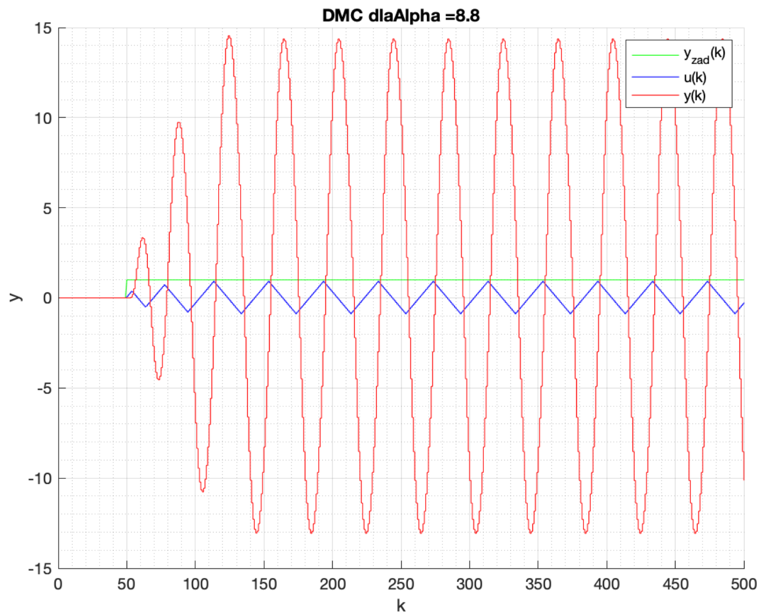

DMC dlaAlpha =2.3
y
k
$y_{zad}(k)$
u(k)
y(k)

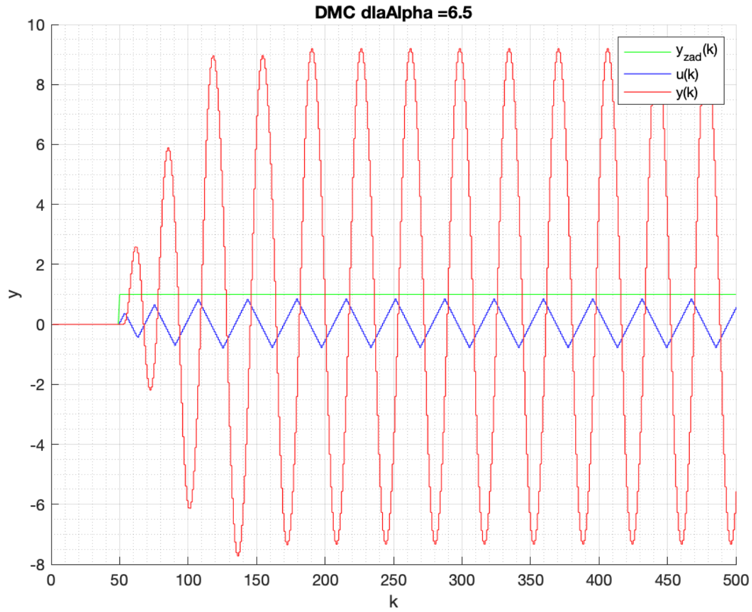

DMC dlaAlpha =1.7
y
k
$y_{zad}(k)$
u(k)
y(k)


DMC dlaAlpha =3.9
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dlaAlpha =5.1
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dlaAlpha =9.2
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dlaAlpha =8.8
$y_{zad}(k)$
u(k)
y(k)
y
k


DMC dlaAlpha =6.5
y
k
y_zad(k)
u(k)
y(k)
10
8
6
4
2
0
-2
-4
-6
-8
0
50
100
150
200
250
300
350
400
450
500