Assignment 5 solutions:

1. Calculate S^u matrix:
   a. Calculate S matrix from code snippet provided
   b. $S^u = \begin{bmatrix} s_1 & 0 \\ s_2 & s_1 \\ s_3 & s_2 \\ s_4 & s_3 \end{bmatrix}$ Where $s_1, s_2 \ldots s_n$ are elements of matrix S.

2. Calculate Hessian Matrix :
   a. $H = [S^u]^T T^y S^u + T^u$

   Where $T^y = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$ $and\ T^u = \begin{bmatrix} 0.5 & 0 \\ 0 & 0.5 \end{bmatrix}$

3. Left hand side i.e. C
   a. $C = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ -1 & 0 \\ 0 & -1 \\ 1 & 0 \\ 1 & 1 \\ -1 & 0 \\ -1 & -1 \end{bmatrix}$
4. Right hand side
   a. $C_{RHS} = \begin{bmatrix} 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 1 \\ 1 \\ 0 \\ 0 \end{bmatrix}$

5. 6. BigSu matrix and Hess matrix:

```
load SVal_CSTR_hw5.mat;  % Load Smodel and nu,ny,n
p=5;
m=2;


% The code must return the matrices bigSu and Hess
% -- Start writing the code from the line below --
col2 = [zeros(2,1);Smodel(1:8)];
bigSu = [Smodel(1:10),col2]
Q = [0.25 0; 0 1];


%Elements of Gy matrix
A = [Q,zeros(2,8)];
B = [zeros(2,2),Q,zeros(2,6)];
C = [zeros(2,4),Q,zeros(2,4)];
D = [zeros(2,6),Q,zeros(2,2)];
E = [zeros(2,8),Q];

%Assigning Gy and Gu matrices
Gy = [A;B;C;D;E];
Gu = [0.1 0;0 0.1];


%calculating Hessian Matrix
Hess = bigSu'*Gy*bigSu + Gu
```

7. 8. BigSu and Hess

```
function [bigSu,Hess]=mimo_dmc_fcn(p,m)
load SVal_MIMO_hw5 Smodel n nu ny


% *** Smodel, n, nu, ny are pre-loaded for you ****
% Please start typing your solution below this line
Q = [1 0;0 1];
R = [0.25 0;0 0.25];


bigSu = zeros(ny*p,nu*m);
J = zeros(ny,nu);
S_init = Smodel(1:ny*p,1:nu)
```

```
for x = 1:m
    for i = 1:nu
        bigSu(:,(x-1)*nu+1:x*nu) = S_init
    end
    S_temp = circshift(S_init,ny,1);
    for j = 1:ny
        for k = 1:nu
            S_temp(j,k) = 0;
        end
    end
        S_init = S_temp;
end
tau_y = zeros(ny*p,ny*p);
tau_u = zeros(m,m);


%Populating tau_y,tau_u
for i = 1:ny*p
    if rem(i,2)==0
        tau_y(i,i) = Q(2,2);
    else
        tau_y(i,i) = Q(1,1);
    end
end
for i = 1:nu*m
    if rem(i,2)==0
        tau_u(i,i) = R(2,2);
    else
        tau_u(i,i) = R(1,1);
    end
end
Hess = (bigSu')*tau_y*bigSu + tau_u
```