```
clc;
clear;

syms s

%sI_A = sym(  [[s+2,-8,-7];[-5,s+4,-2];[9,3,s+1]]  );
%Ident = sym(  [[1,0,0];[0,1,0];[0,0,1]]  );

%%testing
% sum( sI_A(1,:));
% symvar( sum( sI_A(1,:)) );
% symvar( sum( Ident(1,:)) );
% isempty( symvar( sum( Ident(1,:)) ) );

%%function call and work
%format rat
% [~,sI_A_Inv] = gaussJordanN(sI_A,Ident,"Problem 4");
% B = [1;5;-1];
% C = [7,1,2];
% transferFunction = simplify( simplifyFraction( C * sI_A_Inv * B ) );

sI_A = sym(  [[s,-1,0];[0,s-1,-2];[5,4,s+3]]  );
Ident = sym(  [[1,0,0];[0,1,0];[0,0,1]]  );

%%function call and work
format rat
[~,sI_A_Inv] = gaussJordanN(sI_A,Ident,"Problem 3");
B = [0;1;0];
C = [1,0,1];
transferFunction = simplify( simplifyFraction( C * sI_A_Inv * B ) );

"\left[sI-A\right]^{-1} = " + latex(sI_A_Inv)
"$ \frac{Y\left(s\right)}{U\left(s\right)}=" + latex(sym(C))  + "" +
latex(sI_A_Inv) + "" + latex(sym(B)) + "$"
"$ \frac{Y\left(s\right)}{U\left(s\right)}=" + latex(transferFunction) + "$"

% sI_A = sym(  [[s+1,-2,6];[4,s+5,0];[-3,3,s-7]]  );
% [~,sI_A_Inv] = gaussJordanN(sI_A,Ident,"Problem 4")
% B = [5;1;2];
% C = [2,0,2];
% transferFunction = simplifyFraction( C * sI_A_Inv * B )

% sI_A = sym(  [[0,-2,6];[4,s+5,0];[-3,3,s-7]]  );
% [~,sI_A_Inv] = gaussJordanN(sI_A,Ident,"Problem 4")
% B = [1;5;-1];
% C = [7,1,2];
% transferFunction = simplifyFraction( C * sI_A_Inv * B )

%disp("Actual Answer:");
%disp((A^-1)*B);

%%Will first make sure top row has a leading number
```

```
function [L,R] = gaussJordanN(L,R,problemName)
    disp("------   " + problemName + "   ------");
    L;
    R;
    "L = " + latex(L)
    "R = " + latex(R)
    if L(1,1) == 0
         holdingL = L(1,:);
         holdingR = R(1,:);
         nonLeadingZeroesRows = find(L(:,1) ~=0);
         %swap with the last row with a non leading 0
         L(1,:) = L(nonLeadingZeroesRows(end),:);
         R(1,:) = R(nonLeadingZeroesRows(end),:);
         L(nonLeadingZeroesRows(end),:) = holdingL;
         R(nonLeadingZeroesRows(end),:) = holdingR;
         disp( strcat("P(1," + num2str(nonLeadingZeroesRows(end)) + ") ...
In Matlab: " , "L(1,:) = " , "L(" , num2str(nonLeadingZeroesRows(end)) ,
",:) ; ",...
              "R(1,:) = " , "R(" , num2str(nonLeadingZeroesRows(end)) ,
",:)") )

         L;
         R;
        "L = " + latex(L)
        "R = " + latex(R)
    end
    if L(1,1) ~=1
        disp( strcat("M_1(" + char(1/L(1,1)),") ... In Matlab: "  ,"R(1,:) =
","(1/L(1,1))", "*R(1,:)" ," ; L(1,:) = " ,"1/L(1,1))", "*L(1,:)") )
        R(1,:) = 1/L(1,1) * R(1,:);
        L(1,:) = 1/L(1,1) * L(1,:);
        "L = " + latex(L)
        "R = " + latex(R)
    end
    %%Gets into triangular form
    for i = 1:length(L) - 1 % i is the column of interest. Want to ignore
the last column
        %will make all leading numbers except first row to be 0, and so on...
        if isempty( symvar( L(i,i) ) ) == 0 %eqiuvalent of checking if
abs(fac) > 0
            holdingL = L(i,:);
            holdingR = R(i,:);
            nonLeadingZeroesRows = find(L(:,i) ~=0);
            %swap with the last row with a non leading 0
            L(i,:) = L(nonLeadingZeroesRows(end),:);
            R(i,:) = R(nonLeadingZeroesRows(end),:);
            L(nonLeadingZeroesRows(end),:) = holdingL;
            R(nonLeadingZeroesRows(end),:) = holdingR;
            disp( strcat("P(" + num2str(i) + "," +
num2str(nonLeadingZeroesRows(end)) + ") ... In Matlab: " , "L(" ,
num2str(i) ,",:) = " , "L(" , num2str(nonLeadingZeroesRows(end)) , ",:) ;
",...
                "R(" , num2str(i) ,",:) = " , "R(" ,
num2str(nonLeadingZeroesRows(end)) , ",:)") )
```

```
            L = simplifyFraction(L);
            R = simplifyFraction(R);
            L;
            R;
            "L = " + latex(L)
            "R = " + latex(R)
        end
        for ii = 1:height(L)-1
            currentRow = height(L)- (ii - 1);% 0 to height(A)-1 would do the
entire, from bottom to top, so subtract again
            if L(currentRow,i) ~=0
                if currentRow ~= i
                    %disp(L(currentRow,:))
                    fac = -1*L(currentRow,i)/L(i,i);
                    R(currentRow,:) = fac * R(i,:) + R(currentRow,:);
                    L(currentRow,:) = fac * L(i,:) + L(currentRow,:);
                    %if isempty( symvar(fac) ) == 0 %eqiuvalent of checking
if abs(fac) > 0
                        disp(strcat("A_", num2str(i) , " to " , "A_",
num2str(currentRow) ," (" , char(fac) , ") ... In Matlab: " , "R("
, num2str(currentRow) , ",:) = " , "-1*L(",num2str(currentRow), ",",
num2str(i),")"  , "* R(",num2str(i),",:)",...
                        " ; L(" , num2str(currentRow) , ",:) = " ,
"-1*L(",num2str(currentRow), ",", num2str(i),")" , "* L(",num2str(i),",:)") )
                        L = simplifyFraction(L);
                        R = simplifyFraction(R);
                        L;
                        R;
                        "L = " + latex(L)
                        "R = " + latex(R)
                    %end
                end
                arr = find(abs(L(currentRow,:)) > 10^-3); %cant use ~=0,
since floating point.
                if length(arr) == 0
                    continue;
                end
                mult = L(currentRow,arr(1) );
                R(currentRow,:) = R(currentRow,:) * 1/mult;
                L(currentRow,:) = L(currentRow,:) * 1/mult;
                if mult ~=1
                    disp(strcat("M_", num2str(currentRow) ," (1/" ,
char(mult) , ") ... In Matlab: "  , "R(",num2str(currentRow),",:)
= ", "(1/" , "L(",num2str(currentRow),",",char(arr(1)) , "))*R("
,num2str(currentRow),",:)" ,...
                    " ; L(",num2str(currentRow),",:) = ",
"(1/" , "L(",num2str(currentRow),",",char(arr(1)) , "))*L("
,num2str(currentRow),",:)") )
                    L;
                    R;
                    "L = " + latex(L)
                    "R = " + latex(R)
                end
            end
```

```
        end
    end
    %%Will find any rows of all zeroes, and deletes them for now
    z = [];
    for i = 1:height(L)
        %need a tolerance since doing floating point
        if isempty( symvar( sum( L(i,:)) ) ) == 1 %checks if no symbols left
in row
            if abs( double ( sum( L(i,:)) ) ) <= 10^-3
                z = [z,i];
            end
        end
    end
    if length(z) ~=0
        for i = 1:length(z)
            if abs( sum(R(z(i) - (i-1) ,:) ) ) >=10^-3
                disp("system is inconsistent")
            end
            L(z(i) - (i-1) ,:) = [];
            R(z(i) - (i-1) ,:) = [];
        end
        % for i = 1:length(z)
        %     L(height(A) + i,:) = zeros(1,length(A));
        % end
        disp("removed zero row")
        L = simplifyFraction(L);
        R = simplifyFraction(R);
        L;
        R;
        "L = " + latex(L)
        "R = " + latex(R)
    end

    %%Gets into RREF
    for i = 2:height(L)
        i;
       for ii = 1:i-1
            rowToAddTo =  ii;
            fac = -1*L(ii,i)/L(i,i);
            L(rowToAddTo,:) = L(rowToAddTo,:) + fac*L(i,:);
            R(rowToAddTo,:) = R(rowToAddTo,:) + fac*R(i,:);
            if isempty( symvar(fac) ) == 0 %eqiuvalent of checking if
abs(fac) > 0
                disp(strcat("A_", num2str(i) , " to " ,"A_", num2str(ii) ,"
(" , char(fac) , ") ... In Matlab: " , "R(",num2str(ii),",:) =
" ,"-1*L(",num2str(ii),",",num2str(i),")/L(",num2str(i),",",num2str(i),")"
,"*R(",num2str(ii),",:)",...
                    " ; L(",num2str(ii),",:) = "
,"-1*L(",num2str(ii),",",num2str(i),")/L(",num2str(i),",",num2str(i),")"
,"*L(",num2str(ii),",:)") )
            L = simplifyFraction(L);
            R = simplifyFraction(R);
            L;
            R;
```

```
            "L = " + latex(L)
            "R = " + latex(R)
          end
       end
    end
    L;
    R;
    disp(newline)
end
```

```
------   Problem 3   ------

ans =

    "L = \left[\begin{array}{ccc} s & -1 & 0\\ 0 & s-1 & -2\\ 5 & 4 & s+3
\end{array}\right]"


ans =

    "R = \left[\begin{array}{ccc} 1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1
\end{array}\right]"

M_1(1/s) ... In Matlab: R(1,:) = (1/L(1,1))*R(1,:) ; L(1,:) = 1/
L(1,1))*L(1,:)

ans =

    "L = \left[\begin{array}{ccc} 1 & -\frac{1}{s} & 0\\ 0 & s-1 & -2\\ 5 &
4 & s+3 \end{array}\right]"


ans =

    "R = \left[\begin{array}{ccc} \frac{1}{s} & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 &
1 \end{array}\right]"

A_1 to A_3 (-5) ... In Matlab: R(3,:) = -1*L(3,1)* R(1,:) ; L(3,:) =
-1*L(3,1)* L(1,:)

ans =

    "L = \left[\begin{array}{ccc} 1 & -\frac{1}{s} & 0\\ 0 & s-1 & -2\\ 0 &
\frac{4\,s+5}{s} & s+3 \end{array}\right]"


ans =

    "R = \left[\begin{array}{ccc} \frac{1}{s} & 0 & 0\\ 0 & 1 & 0\\ -\frac{5}
{s} & 0 & 1 \end{array}\right]"

M_3 (1/(4*s + 5)/s) ... In Matlab: R(3,:) = (1/L(3, ))*R(3,:) ; L(3,:) = (1/
L(3, ))*L(3,:)
```

```
ans =

    "L = \left[\begin{array}{ccc} 1 & -\frac{1}{s} & 0\\ 0 & s-1 & -2\\ 0 &
1 & \frac{s\,\left(s+3\right)}{4\,s+5} \end{array}\right]"


ans =

    "R = \left[\begin{array}{ccc} \frac{1}{s} & 0 & 0\\ 0 & 1 & 0\\ -\frac{5}
{4\,s+5} & 0 & \frac{s}{4\,s+5} \end{array}\right]"

P(2,3) ... In Matlab: L(2,:) = L(3,:) ; R(2,:) = R(3,:)

ans =

    "L = \left[\begin{array}{ccc} 1 & -\frac{1}{s} & 0\\ 0 & 1 &
\frac{s\,\left(s+3\right)}{4\,s+5}\\ 0 & s-1 & -2 \end{array}\right]"


ans =

    "R = \left[\begin{array}{ccc} \frac{1}{s} & 0 & 0\\ -\frac{5}{4\,s+5} &
0 & \frac{s}{4\,s+5}\\ 0 & 1 & 0 \end{array}\right]"

A_2 to A_3 (1 - s) ... In Matlab: R(3,:) = -1*L(3,2)* R(2,:) ; L(3,:) =
-1*L(3,2)* L(2,:)

ans =

    "L = \left[\begin{array}{ccc} 1 & -\frac{1}{s} & 0\\ 0 & 1
& \frac{s\,\left(s+3\right)}{4\,s+5}\\ 0 & 0 & -\frac{s^3+2\,s^2+5\,s+10}
{4\,s+5} \end{array}\right]"


ans =

    "R = \left[\begin{array}{ccc} \frac{1}{s} & 0 & 0\\ -\frac{5}{4\,s+5}
& 0 & \frac{s}{4\,s+5}\\ \frac{5\,\left(s-1\right)}{4\,s+5} & 1 & -
\frac{s\,\left(s-1\right)}{4\,s+5} \end{array}\right]"

M_3 (1/-(5*s + 2*s^2 + s^3 + 10)/(4*s + 5)) ... In Matlab: R(3,:) = (1/
L(3, ))*R(3,:) ; L(3,:) = (1/L(3, ))*L(3,:)

ans =

    "L = \left[\begin{array}{ccc} 1 & -\frac{1}{s} & 0\\ 0 & 1 &
\frac{s\,\left(s+3\right)}{4\,s+5}\\ 0 & 0 & 1 \end{array}\right]"


ans =

    "R = \left[\begin{array}{ccc} \frac{1}{s} & 0 & 0\\ -\frac{5}{4\,s+5}
& 0 & \frac{s}{4\,s+5}\\ -\frac{5\,\left(s-1\right)}{s^3+2\,s^2+5\,s+10}
& -\frac{4\,s+5}{s^3+2\,s^2+5\,s+10} & \frac{s\,\left(s-1\right)}
```

```
{s^3+2\,s^2+5\,s+10} \end{array}\right]"

A_2 to A_1 (1/s) ... In Matlab: R(1,:) = -1*L(1,2)/L(2,2)*R(1,:) ; L(1,:) =
-1*L(1,2)/L(2,2)*L(1,:)

ans =

    "L = \left[\begin{array}{ccc} 1 & 0 & \frac{s+3}{4\,s+5}\\ 0 & 1 &
\frac{s\,\left(s+3\right)}{4\,s+5}\\ 0 & 0 & 1 \end{array}\right]"


ans =

    "R = \left[\begin{array}{ccc} \frac{4}{4\,s+5} & 0
& \frac{1}{4\,s+5}\\ -\frac{5}{4\,s+5} & 0 & \frac{s}{4\,s+5}\
\ -\frac{5\,\left(s-1\right)}{s^3+2\,s^2+5\,s+10} & -\frac{4\,s+5}
{s^3+2\,s^2+5\,s+10} & \frac{s\,\left(s-1\right)}{s^3+2\,s^2+5\,s+10}
\end{array}\right]"

A_3 to A_1 (-(s + 3)/(4*s + 5)) ... In Matlab: R(1,:) = -1*L(1,3)/
L(3,3)*R(1,:) ; L(1,:) = -1*L(1,3)/L(3,3)*L(1,:)

ans =

    "L = \left[\begin{array}{ccc} 1 & 0 & 0\\ 0 & 1 &
\frac{s\,\left(s+3\right)}{4\,s+5}\\ 0 & 0 & 1 \end{array}\right]"


ans =

    "R = \left[\begin{array}{ccc} \frac{s^2+2\,s+5}{s^3+2\,s^2+5\,s+10}
& \frac{s+3}{s^3+2\,s^2+5\,s+10} & \frac{2}{s^3+2\,s^2+5\,s+10}\\ -
\frac{5}{4\,s+5} & 0 & \frac{s}{4\,s+5}\\ -\frac{5\,\left(s-1\right)}
{s^3+2\,s^2+5\,s+10} & -\frac{4\,s+5}{s^3+2\,s^2+5\,s+10} &
\frac{s\,\left(s-1\right)}{s^3+2\,s^2+5\,s+10} \end{array}\right]"

A_3 to A_2 (-(s*(s + 3))/(4*s + 5)) ... In Matlab: R(2,:) = -1*L(2,3)/
L(3,3)*R(2,:) ; L(2,:) = -1*L(2,3)/L(3,3)*L(2,:)

ans =

    "L = \left[\begin{array}{ccc} 1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1
\end{array}\right]"


ans =

    "R = \left[\begin{array}{ccc} \frac{s^2+2\,s+5}{s^3+2\,s^2+5\,s+10}
& \frac{s+3}{s^3+2\,s^2+5\,s+10} & \frac{2}{s^3+2\,s^2+5\,s+10}\\ -\frac{10}
{s^3+2\,s^2+5\,s+10} & \frac{s\,\left(s+3\right)}{s^3+2\,s^2+5\,s+10}
& \frac{2\,s}{s^3+2\,s^2+5\,s+10}\\ -\frac{5\,\left(s-1\right)}
{s^3+2\,s^2+5\,s+10} & -\frac{4\,s+5}{s^3+2\,s^2+5\,s+10} &
\frac{s\,\left(s-1\right)}{s^3+2\,s^2+5\,s+10} \end{array}\right]"
```

```
ans =

    "\left[sI-A\right]^{-1} = \left[\begin{array}{ccc}
\frac{s^2+2\,s+5}{s^3+2\,s^2+5\,s+10} & \frac{s+3}{s^3+2\,s^2+5\,s+10}
& \frac{2}{s^3+2\,s^2+5\,s+10}\\ -\frac{10}{s^3+2\,s^2+5\,s+10}
& \frac{s\,\left(s+3\right)}{s^3+2\,s^2+5\,s+10} & \frac{2\,s}
{s^3+2\,s^2+5\,s+10}\\ -\frac{5\,\left(s-1\right)}{s^3+2\,s^2+5\,s+10}
& -\frac{4\,s+5}{s^3+2\,s^2+5\,s+10} & \frac{s\,\left(s-1\right)}
{s^3+2\,s^2+5\,s+10} \end{array}\right]"


ans =

    "$ \frac{Y\left(s\right)}{U\left(s\right)}=\left[\begin{array}{ccc}
1 & 0 & 1 \end{array}\right]\left[\begin{array}{ccc}
\frac{s^2+2\,s+5}{s^3+2\,s^2+5\,s+10} & \frac{s+3}{s^3+2\,s^2+5\,s+10}
& \frac{2}{s^3+2\,s^2+5\,s+10}\\ -\frac{10}{s^3+2\,s^2+5\,s+10}
& \frac{s\,\left(s+3\right)}{s^3+2\,s^2+5\,s+10} & \frac{2\,s}
{s^3+2\,s^2+5\,s+10}\\ -\frac{5\,\left(s-1\right)}{s^3+2\,s^2+5\,s+10}
& -\frac{4\,s+5}{s^3+2\,s^2+5\,s+10} & \frac{s\,\left(s-1\right)}
{s^3+2\,s^2+5\,s+10} \end{array}\right]\left[\begin{array}{c} 0\\ 1\\ 0
\end{array}\right]$"


ans =

    "$ \frac{Y\left(s\right)}{U\left(s\right)}=-\frac{3\,s+2}
{s^3+2\,s^2+5\,s+10}$"
```

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