Assignment 10
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ECE 309
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Main Script

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% *******************************************************
% Program Name: Solve_test.m
% Author: Juan Silva Last Modified: May 9, 2018
% Description: This main function receive two inputs, a
% square matrix and a column vector, then produces a table
% comparing our calculated value versus Matlab's built-in
% inverse function times the original column vector.
% *******************************************************

clear, clc, close all
format short, format compact

%Table variables
var1 = ['x' 'y' 'z']';          %Systems 1 - 3
var2 = ['x' 'y']';              %System 4
var3 = ['v' 'w' 'x' 'y' 'z']';  %System 5

% ******** Question 1 ********
A = [3 4 1; 2 -2 -1; 5 4 0.5];
b = [7 -1 9];
[Ap1, bp1, X1, Xinv1] = Solve(A,b);
table(var1,X1,Xinv1,'VariableNames',{'Unknowns'  'Solve' 'Inv'})
fprintf('\n\t\t\t\tSystem 1\n')

% ******** Question 2 ********
A = [1 0 1; 2 -1 -1; 7 -2 2];
b = [12 1 8];
[Ap2, bp2, X2, Xinv2] = Solve(A,b);
table(var1,X2,Xinv2,'VariableNames',{'Unknowns'  'Solve' 'Inv'})
fprintf('\n\t\tSystem 2\n')

% ******** Question 3 ********
A = [1 -1 2; 0 0 4; 0 2 -1];
b = [22 44 9];
[Ap2, bp2, X2, Xinv2] = Solve(A,b);
table(var1,X2,Xinv2,'VariableNames',{'Unknowns'  'Solve' 'Inv'})
fprintf('\n\t\tSystem 3\n')

% ******** Question 4 ********
A = [0.0001 1; 1 1];
b = [1 2];
[Ap4, bp4, X4, Xinv4] = Solve(A,b);
table(var2,X4,Xinv4,'VariableNames',{'Unknowns'  'Solve' 'Inv'})
fprintf('\n\t\t\t\tSystem 4\n')
```

```
% ******** Question 5 ********
A = [0 -1 2 1 1; 1 1 1 -1 1; 2 1 3 2 2; 2 -3 -4 3 0; 1 5 0 0 -1];
b = [4 4 12 7 -1];
[Ap5, bp5, X5, Xinv5] = Solve(A,b);
table(var3,X5,Xinv5,'VariableNames',{'Unknowns'  'Solve' 'Inv'})
fprintf('\n\t\t\t\t\tSystem 5\n')
```

Function Script

```
% ******************************************************
% Program Name: Solve.m
% Author: Juan Silva Last Modified: May 9, 2018
% Description: This function will produce the row echelon
% form of a given matrix, applies back-substitution to
% produce the solution vector and returns four outputs.
% It will return the upper triangular matrix and its modified
% column vector, the solution column vector, and Matlab's
% inverse * b calculation.
% ******************************************************

function [Ap, bp, X, Xinv] = Solve(A,b)

N = length(A);

S = size(A);
m = S(1);
n = S(2);

if m ~= n
    disp('Error. Matrix entered must be a square matrix.')
    M = A;
    x = b';
    return

else

% *** ROW ECHELON FORM ***

for k = 1:N              %loop through all columns
    for i = k:N          %loop through all rows
        if i == k
            if abs(A(i,i)) < 0.01
              A([i, N],:) = A([N, i], :);
              b(:,[i, N]) = b(:,[N, i]);
            end
           continue
        end

        lambda = A(i,k) / A(k,k);
        A(i,k:N) = A(i,k:N) - lambda * A(k,k:N);
        b(i) = b(i) - lambda * b(k);
    end

    if A(k,k) ~= 1
        b(:,k) = b(k) .* inv(A(k,k));
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```
        A(k,:) = A(k,:) .* inv(A(k,k));
    end
end

% *** BACK SUBSTITUTION ***

M = [A b'];
A = M(:,1:N);
b = M(:,N+1);
temp = b;           %save column before back sub

for i=N:-1:1

    %Divide pivot to b column vector
    b(i) = b(i) / A(i,i);

    %Apply backwards substitution
    b(1:i-1) = b(1:i-1) - A(1:i-1,i) * b(i);

    x = b;      %back substituion
end

Ap = A;             %REF matrix
bp = temp;          %column vector after REF
X = b;              %column vector after back sub
Xinv =  A\temp;     %invA * b

end
end
```

Results

1. $3x + 4y + z = 7$
   $2x - 2y - z = -1$
   $5x + 4y + 0.5z = 9$

Unknowns	Solve	Inv
x	0.33333	0.33333
y	2.1667	2.1667
z	-2.6667	-2.6667

System 1

2. $x + z = 12$
$2x - y - z = 1$
$7x - 2y + 2z = 8$

Unknowns	Solve	Inv
x	42	42
y	113	113
z	-30	-30

System 2

3. $x - y + 2z = 22$
$4z = 44$
$2y - z = 9$

Unknowns	Solve	Inv
x	10	10
y	10	10
z	11	11

System 3

4. $0.0001x + y = 1$
$x + y = 2$

Unknowns	Solve	Inv
x	1.0001	1.0001
y	0.9999	0.9999

System 4

5.

$$-w + 2x + y + z = 4$$
$$v + w + x - y + z = 4$$
$$2v + w + 3x + 2y + 2z = 12$$
$$2v - 3w - 4x + 3y = 7$$
$$v + 5w - z = -1$$

Unknowns	Solve	Inv
v	2	2
w	0	0
x	0	0
y	1	1
z	3	3

System 5