**Experiment: 03**

**Date: 06.04.2022**

**Program Name:**

1. **Write a menu-driven MATLAB program for obtaining Degenerate and Non-degenerate Basic Solutions, Basic Feasible Solutions.**
2. **Using your code get the results of the following problems:**

**Find all basic solutions for the system of simultaneous equations. Determine the degenerate and non-degenerate basic solutions and basic feasible solutions separately.**

1. **Obtain all extreme points and the corresponding optimal solution of the following LPP:**

**𝑀𝑎ximize**

**𝑀𝑎ximize**

**Theory:**

1. **Basic Solution: Given a system of simultaneous linear equations variables (unknowns) .**

**Where, is an matrix of rank .**

**Let, be any sub-matrix formed by linearly independent columns of .**

**Then a solution obtained by setting variables not associated with the columns of , equal to zero and solving the resulting system is called a Basic Solution to the given system of equations.**

**Here,**

1. **The variables which may be all different from Zero , are called Basic Variables.**

**The non-singular sub-matrix is called basic matrix whose columns are called basis vactors.**

1. **If is basic submatrix then the basic solution to the system is ,**
2. **Degenerate Basic Solution : A Basic Solution to the system is called Degenerate if one or more of the Basic Variables vanish ( i.e., value of the variables is zero ).**
3. **Non-Degenerate Basic Solution : A Basic Solution to the system is called Non-Degenerate if none of the Basic Variables vanishes .**
4. **Feasible Solution: A Feasible solution to a L.P.P. is a set of values of the variables, which satisfy all the constraints and all the non-negative restrictions of the variables, is known as the feasible solution (F.S.) to the LPP.**
5. **Basic Feasible Solution (B.F.S.) :** **A Feasible Solution (F.S.) to a LPP which is also a Basic Solution to the problem is called a Basic Feasible Solution (B.F.S.) to the L.P.P. .**

**Program Code:**

* **Program Code : For Build a function gauss\_elimination**

**(gauss\_elimination.m)**

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**function x = gauss\_elimination(A,b)**

**[m,n] = size(A);**

**if ( m == n)**

**Aug =[A b];**

**for k = 1 : (n-1)**

**[big ip] = max(abs(Aug(k:m,k)));**

**ipr = ip +k-1 ;**

**if (ipr ~= k)**

**Aug([k ipr],:) =Aug([ipr k],:);**

**end**

**for i = (k +1) : n**

**factor = Aug(i,k)/Aug(k,k);**

**for j=1 : (n+1)**

**Aug(i,j) =(Aug(i,j)-(factor\*Aug(k,j)));**

**end**

**end**

**end**

**x = [];**

**x(n) = Aug(n,n+1)/ Aug(n,n);**

**for i=(n-1):-1: 1**

**Sum = 0;**

**for j = n:-1:(i+1)**

**Sum = Sum + Aug(i,j)\*x(j) ;**

**end**

**x(i) =( Aug(i,n+1) -Sum)/Aug(i,i);**

**end**

**end**

**end**

1. **Program Code :( Write a menu-driven MATLAB program for obtaining Degenerate and Non-degenerate Basic Solutions, Basic Feasible Solutions.)**

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**clc;**

**clearvars;**

**A = input('Enter the coefficients matrix : ');**

**b = input('Enter the right hand side vector : ');**

**[m,n] = size(A);**

**combo = nchoosek(1:n,m);**

**[m1 n1] = size(combo);**

**nbs = nchoosek(n,m);**

**Deg= [];**

**Non\_Deg=[];**

**B\_F\_S=[];**

**for i = 1 :nbs**

**x = zeros(n,1);**

**bas\_mat = [ ];**

**for j = 1 :n1**

**bas\_mat = [bas\_mat A(:,combo(i,j))];**

**end**

**bas\_mat;**

**y = gauss\_elimination(bas\_mat,b);**

**if( max(y) ~= Inf )**

**for j = 1 : n1**

**x(combo(i,j),1) = y(j);**

**end**

**disp('Basic solution is: ');**

**x**

**if( min(x) >= 0 )**

**B\_F\_S = [B\_F\_S x];**

**disp(' This is a Basic Feasible solution.');**

**else**

**disp (' This is a Basic Infeasible solution.');**

**end**

**if(y == 0)**

**Deg = [Deg x];**

**disp('This is Degenerate Basic solution.');**

**else**

**Non\_Deg =[Non\_Deg x];**

**disp ('This is Non Degenerate Basic solution.' );**

**end**

**else**

**disp( 'In this case no Basic solution exist. ' );**

**end**

**end**

**disp('D: Degenerate Solution, ND: Non Degenerate Solution, BFS: Basic Feasible Solution');**

**choice = menu( ' Choose','D',' ND','BFS');**

**switch choice**

**case 1**

**[D1,D2]=size(Deg);**

**if (D1 < 1)**

**disp('No Degenerate Solution..')**

**else**

**disp(Deg) ;**

**end**

**case 2**

**[ND1,ND2]=size(Non\_Deg);**

**if (ND1 < 1)**

**disp('No Non Degenerate Solution..')**

**else**

**disp(Non\_Deg) ;**

**end**

**case 3**

**[BFS1,BFS2]=size(B\_F\_S);**

**if (BFS1 < 1)**

**disp('No Basic Feasible Solution..')**

**else**

**disp(B\_F\_S) ;**

**end**

**end**

1. **Using your code get the results of the following problems:**

**Find all basic solutions for the system of simultaneous equations. Determine the degenerate and non-degenerate basic solutions and basic feasible solutions separately.**

**Output: For**

**Enter the coefficients matrix : [2 3 4;3 4 5]**

**Enter the right hand side vector : [5;6]**

**Basic solution is:**

**x =**

**-2.0000**

**3.0000**

**0**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**-0.5000**

**0**

**1.5000**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**-1**

**2**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**D: Degenerate Solution, ND: Non Degenerate Solution, BFS: Basic Feasible Solution**

**1.For Choosing D :**

**No Degenerate Solution..**

**2.For Choosing ND :**

**-2.0000 -0.5000 0**

**3.0000 0 -1.0000**

**0 1.5000 2.0000**

**3.For Choosing BFS :**

**No Basic Feasible Solution..**

**Output: For**

**Enter the coefficients matrix : [2 1 4;3 1 5]**

**Enter the right hand side vector : [11;14]**

**Basic solution is:**

**x =**

**3.0000**

**5.0000**

**0**

**This is a Basic Feasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0.5000**

**0**

**2.5000**

**This is a Basic Feasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**-1**

**3**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**D: Degenerate Solution, ND: Non Degenerate Solution, BFS: Basic Feasible Solution**

**1.For Choosing D :**

**No Degenerate Solution..**

**2.For Choosing ND:**

**3.0000 0.5000 0**

**5.0000 0 -1.0000**

**0 2.5000 3.0000**

**3.For Choosing BFS :**

**3.0000 0.5000**

**5.0000 0**

**0 2.5000**

**Output: For**

**Enter the coefficients matrix : [3 1 5 1 0;2 4 1 0 2]**

**Enter the right hand side vector : [12;8]**

**Basic solution is:**

**x =**

**4**

**0**

**0**

**0**

**0**

**This is a Basic Feasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**4**

**0**

**0**

**0**

**0**

**This is a Basic Feasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**4**

**0**

**0**

**0**

**0**

**This is a Basic Feasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**4**

**0**

**0**

**0**

**0**

**This is a Basic Feasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**1.4737**

**2.1053**

**0**

**0**

**This is a Basic Feasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**2**

**0**

**10**

**0**

**This is a Basic Feasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**12**

**0**

**0**

**-20**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**0**

**8.0000**

**-28.0000**

**0**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**0**

**2.4000**

**0**

**2.8000**

**This is a Basic Feasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**0**

**0**

**12**

**4**

**This is a Basic Feasible solution.**

**This is Non Degenerate Basic solution.**

**D: Degenerate Solution, ND: Non Degenerate Solution, BFS: Basic Feasible Solution**

**1.For Choosing D :**

**No Degenerate Solution..**

**2.For Choosing ND :**

**Columns 1 through 8**

**4.0000 4.0000 4.0000 4.0000 0 0 0 0**

**0 0 0 0 1.4737 2.0000 12.0000 0**

**0 0 0 0 2.1053 0 0 8.0000**

**0 0 0 0 0 10.0000 0 -28.0000**

**0 0 0 0 0 0 -20.0000 0**

**Columns 9 through 10**

**0 0**

**0 0**

**2.4000 0**

**0 12.0000**

**2.8000 4.0000**

**3.For Choosing BFS:**

**4.0000 4.0000 4.0000 4.0000 0 0 0 0**

**0 0 0 0 1.4737 2.0000 0 0**

**0 0 0 0 2.1053 0 2.4000 0**

**0 0 0 0 0 10.0000 0 12.0000**

**0 0 0 0 0 0 2.8000 4.0000**

**Output: For**

**Enter the coefficients matrix : [2 6 2 4;6 4 4 6]**

**Enter the right hand side vector : [3;22]**

**Basic solution is:**

**x =**

**4.2857**

**-0.9286**

**0**

**0**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**8.0000**

**0**

**-6.5000**

**0**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**5.8333**

**0**

**0**

**-2.1667**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**-2.0000**

**7.5000**

**0**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**-3.5000**

**0**

**6.0000**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**Basic solution is:**

**x =**

**0**

**0**

**17.5000**

**-8.0000**

**This is a Basic Infeasible solution.**

**This is Non Degenerate Basic solution.**

**D: Degenerate Solution, ND: Non Degenerate Solution, BFS: Basic Feasible Solution**

**1.For Choosing D :**

**No Degenerate Solution..**

**2.For Choosing ND :**

**4.2857 8.0000 5.8333 0 0 0**

**-0.9286 0 0 -2.0000 -3.5000 0**

**0 -6.5000 0 7.5000 0 17.5000**

**0 0 -2.1667 0 6.0000 -8.0000**

**3.For Choosing BFS:**

**No Basic Feasible Solution..**

1. **Program Code: Obtain all extreme points and the corresponding optimal solution of the following LPP:**

**𝑀𝑎ximize**

**𝑀𝑎ximize**

**Program Code:**

**For 𝑀𝑎ximize**

**%ANINDYA NAG**

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**clc;**

**clearvars;**

**A = input('Enter the coefficients matrix : ');**

**b = input('Enter the right hand side vector : ');**

**opt\_value=0;**

**[m,n] = size(A);**

**combo = nchoosek(1:n,m);**

**[m1 n1] = size(combo);**

**nbs = nchoosek(n,m);**

**for i = 1 :nbs**

**x = zeros(n,1);**

**bas\_mat = [ ];**

**for j = 1 :n1**

**bas\_mat = [bas\_mat A(:,combo(i,j))];**

**end**

**bas\_mat;**

**y = gauss\_elimination(bas\_mat,b);**

**if( max(y) ~= Inf )**

**for j = 1 : n1**

**x(combo(i,j),1) = y(j);**

**end**

**%disp('Basic solution is: ');**

**x;**

**if( min(x) >= 0 )**

**%disp(' This is a Basic Feasible solution.');**

**z= 5\*x(1,1) + 3\*x(2,1);**

**if ( opt\_value <= z)**

**opt\_value = z;**

**opt\_soln =x ;**

**end**

**end**

**end**

**end**

**fprintf('Optimal Value is: %0.2f\n',opt\_value)**

**fprintf('Optimal solution is: \n x1=%0.2f \n x2=%0.2f \n x3=%0.2f \n x4=%0.2f \n',opt\_soln(1,1),opt\_soln(2,1),opt\_soln(3,1),opt\_soln(4,1))**

**Output:**

**For 𝑀𝑎ximize**

**Enter the coefficients matrix : [3 5 1 0;5 2 0 1]**

**Enter the right hand side vector : [15;10]**

**Optimal Value is: 12.37**

**Optimal solution is:**

**x1=1.05**

**x2=2.37**

**x3=0.00**

**x4=0.00**

**>>**

**Program Code:**

**For 𝑀𝑎ximize**

**%ANINDYA NAG**

**%UG/02/BTCSE/2018/005**

**clc;**

**clearvars;**

**A = input('Enter the coefficients matrix : ');**

**b = input('Enter the right hand side vector : ');**

**opt\_value=0;**

**[m,n] = size(A);**

**combo = nchoosek(1:n,m);**

**[m1 n1] = size(combo);**

**nbs = nchoosek(n,m);**

**for i = 1 :nbs**

**x = zeros(n,1);**

**bas\_mat = [ ];**

**for j = 1 :n1**

**bas\_mat = [bas\_mat A(:,combo(i,j))];**

**end**

**bas\_mat;**

**y = gauss\_elimination(bas\_mat,b);**

**if( max(y) ~= Inf )**

**for j = 1 : n1**

**x(combo(i,j),1) = y(j);**

**end**

**%disp('Basic solution is: ');**

**x;**

**if( min(x) >= 0 )**

**%disp(' This is a Basic Feasible solution.');**

**z= 2\*x(1,1) + x(2,1);**

**if ( opt\_value <= z)**

**opt\_value = z;**

**opt\_soln =x ;**

**end**

**end**

**end**

**end**

**fprintf('Optimal Value is: %0.2f\n',opt\_value)**

**fprintf('Optimal solution is: \n x1=%0.2f \n x2=%0.2f \n x3=%0.2f \n x4=%0.2f \n',opt\_soln(1,1),opt\_soln(2,1),opt\_soln(3,1),opt\_soln(4,1))**

**Output:**

**For 𝑀𝑎ximize**

**Enter the coefficients matrix : [1 2 1 0 0;1 1 0 1 0;1 -2 0 0 1]**

**Enter the right hand side vector : [10;6;1]**

**Optimal Value is: 10.33**

**Optimal solution is:**

**x1=4.33**

**x2=1.67**

**x3=2.33**

**x4=0.00**

**>>**