1. LINGO (download LINGO7 from www.lindo.com for temporary license)

1) Design of a Bear Can

```
!Design of a Bear Can;
!Objective;
min=obj;
obj=3.1415926*D*H+3.1415926*D^2/2;
!constraint;
g=3.1415926*D^2*H/4;
g>=400;
!Define the ranges for D and H;
@BND(3.5,D,8);
@BND(8,H,18);
!Define the Starting Point;
init:
D=0;
H=0;
endinit
```

```
result
Local optimal solution found at step:             3
 Objective value:                         300.5303

                     Variable           Value        Reduced Cost
                          OBJ        300.5303           0.0000000
                            D        7.978846           0.0000000
                            H        8.000000           0.3314442E-01
                            G        400.0000           0.0000000

                          Row    Slack or Surplus      Dual Price
                            1        300.5303            1.000000
                            2      -0.2713481E-06       -1.000000
                            3      -0.1048908E-05        0.5006628
                            4       0.0000000           -0.5006628
```

2) Design of a Weight Tubular Column

```
!Design of a Weight Tubular Column;
!Objective;
min=2.4608E5*(R/100)*(t/100);
!Constraints;
10E6/(2*PI*(R/100)*(t/100))-248E6<=0;
10*1E6-PI^3*207E9*(R/100)^3*(t/100)/(4*5*5)<=0;
-(R/100)<=0;
-(t/100)<=0;
PI=3.1415926;
!Starting Point;
init:
R=16;
t=4.;
endinit
```

```
Result
Local optimal solution found at step:             38
 Objective value:                         1579.228

                     Variable           Value        Reduced Cost
                            R        78.01818           0.0000000
                            T       0.8225696           0.0000000
                           PI        3.141593           0.0000000

                          Row    Slack or Surplus      Dual Price
                            1        1579.228          -1.000000
                            2       0.3814697E-04       0.6367857E-05
                            3       0.2407148E+09       0.0000000
                            4       0.7801818           0.0000000
                            5       0.8225696E-02       0.0000000
                            6       0.0000000            502.6450
```

You will observe that depending on the starting point, the program will converge to different solutions. All these solutions will have the same objective value but different values of design variables. These are considered as "alternative solutions" (see pg.55, Figure 2.10).

3) Design of a Weight Tubular Column with One Integer Design Variable

R is an integer variable.

```
!Design of a Weight Tubular Column;
!Objective;
min=2.4608E5*(R/100)*(t/100);
!Constraints;
10E6/(2*PI*(R/100)*(t/100))-248E6<=0;
10*1E6-PI^3*207E9*(R/100)^3*(t/100)/(4*5*5)<=0;
-(R/100)<=0;
-(t/100)<=0;
PI=3.1415926;
!Integer;
@GIN(R);
!Starting Point;
init:
R=16;
t=4.;
endinit
```

Result

```
Local optimal solution found at step:             26
 Objective value:                         1579.228
 Branch count:                                   2

                     Variable           Value        Reduced Cost
                            R        16.00000           0.0000000
                            T        4.010961           0.0000000
                           PI        3.141593           0.0000000

                          Row    Slack or Surplus      Dual Price
                            1        1579.228          -1.000000
                            2      -0.4792213E-04       0.6367857E-05
                            3        544557.6           0.0000000
```

```
4       0.1600000           0.0000000
5       0.4010961E-01       0.0000000
6       0.0000000            502.6450
```

2. MATLAB

1) Design of a Bear Can

Main Program (myfile1.m)

```
%define starting point
x0=[0,0];

%define the ranges for the design variables
vlb=[3.5,8];
vub=[8,18];

x=constr('fun1',x0,[],vlb,vub)
[f,g]=fun1(x)
```

Function defining the objective f and constraint g (fun1.m)

```
function [f,g]=fun1(x)
D=x(1);
H=x(2);
f=pi*D*H+pi*D^2/2;
g(1)=400-pi*D^2*H/4;
```

Result:

» myfile1

x =

7.9788 8.0000

f =

300.5303

g =

0

If using starting point

2) Design of a Weight Tubular Column

Main Program(myfile2.m)

```
%define startig point
x0=[16,4];
x=constr('fun2',x0)
[f,g]=fun2(x)
```

Function of the objective f and constraint g (fun2.m)

```
function [f,g]=fun2(x)
R=x(1);
t=x(2);
f=2.4608E5*(R/100)*(t/100);;
g(1)=10E6/(2*PI*(R/100)*(t/100))-248E6;
g(2)= 10*1E6-PI^3*207E9*(R/100)^3*(t/100)/(4*5*5);
g(3)=-R/100;
g(4)=-t/100;
```

Result

» myfile2

```
x =

   16.0026    4.0103


f =

  1.5792e+003


g =

  1.0e+005 *

    0.0000   -5.4800   -0.0000   -0.0000
```