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MSC PHD (OR)

Exercise 1):

Q3)(R)

The following question has been solved by ampl and the files are uploaded with the report

AMPL

```
ampl: include ex1.run;
Gurobi 8.0.0: optimal solution; objective 103.8
cost = 103.8

x[i] [*] :=
1  1
2  1
3  2
4  0
5  7
6  0
7  2
;

con1.ub = 30
con1.lb = -Infinity
```

1) The optimal solution came out to be:103.8

2) The values are variables at optimal solution is:

X[1]=1

X[2]=1

X[3]=2

X[4]=0

X[5]=7

X[6]=0

X[7]=2

3) The bounds of constraints are as follows:

con1.ub = 30
con1.lb = -Infinity

Q4)(R) The following question has been solved by ampl and the files are uploaded with the report

AMPL

```
ampl: include ex1_new.run;
Gurobi 8.0.0: optimal solution; objective 207.6
cost = 207.6

x[i] [*] :=
 1  1
 2  1
 3  2
 4  0
 5  7
 6  0
 7  2
 8  1
 9  1
10  2
11  0
12  7
13  0
14  2
;

con1.ub = 60
con1.lb = -Infinity
```

1) The optimal solution came out to be:207.6

2) The values are variables at optimal solution is:

x[1]= 1
x[2]=1
x[3]=2
x[4]=0
x[5]=7
x[6]=0
x[7]=2
x[8]=1
x[9]=1
x[10]=2
x[11]=0
x[12]=7
x[13]=0
x[14]=2

3) The bounds of constraints are as follows:

con1.ub = 60
con1.lb = -Infinity

Exercise 2):

Q5)(R) the lpp is as follows:

minimize x1+x2+x3+x4+x5+x6;

subject to constraints:

x1>=155000-b0-b1*12000-b2*350;
x1>=-155000+b0+b1*12000+b2*350;
x2>=120000-b0-b1*10000-b2*300;
x2>=-120000+b0+b1*10000+b2*300;
x3>=100000-b0-b1*9000-b2*100;
x3>=-100000+b0+b1*9000+b2*100;
x4>=70000-b0-b1*8000-b2*200;
x4>=-70000+b0+b1*8000+b2*200;
x5>=60000-b0-b1*6000-b2*100;
x5>=-60000+b0+b1*6000+b2*100;
x6>=100000-b0-b1*9000-b2*200;
x6>=-100000+b0+b1*9000+b2*200;

where x1>=0;x2>=0;x3>=0;x4>=0;x5>=0;x6>=0;b0>=0;b1&b2 belongs to real;
where xi=|P_i-$\widehat{Pi}$|, P_i = selling price and $\widehat{Pi}$ = estimated value of P_i.

```
AMPL
ampl: include ex2b.run;
Gurobi 8.0.0: optimal solution; objective 171626.789
64 simplex iterations
residual = 171627

x[i] [*] :=
 1  4579.56     13  8418.51     25     0        37  3371.47     49   628.687
 2  4764.06     14   276.851    26   606.441    38  5839.45     50  3789.05
 3  2462.23     15  6154.6      27  2620.1      39   625.358    51    42.3149
 4  1704.42     16  1418.14     28  1874.14     40  1218.39     52   241.848
 5   513.535    17  2896.42     29  3943.81     41  1705.04     53  3573.12
 6  2442.5      18  2984.47     30  1172.5      42  1904.2      54  2575.86
 7  2849.35     19  2433.07     31  1707.19     43  5051.8      55 11681.7
 8     0        20   765.09     32  2064.72     44  2648.57     56  3426.14
 9  2126.94     21  1369.51     33  2196.64     45  6491.66     57  8235.03
10  3355.16     22   197.946    34  4386.9      46  2880.43     58  1632.2
11  4983.35     23  5845.12     35     0        47  3160.92     59  1040.57
12  2393.9      24  8637.52     36  2445.61     48   107.063    60  3165.56
;

b0 = 10499.5
b1 = 4.54885
b2 = 123.354
```

1) The optimal solution came out to be:171627

2) The values are variables at optimal solution is:

```
 x1 4579.56     x13  8418.51     x25     0        x37  3371.47     x49   628.687
 x2  4764.06     x14   276.851    x26   606.441    x38  5839.45     x50  3789.05
 x3 2462.23     x15  6154.6      x27  2620.1      x39   625.358    x51    42.3149
 x4  1704.42     x16  1418.14     x28  1874.14     x40  1218.39     x52   241.848
 x5  513.535    x17  2896.42     x29  3943.81     x41  1705.04     x53  3573.12
 x6  2442.5      x18  2984.47     x30  1172.5      x42  1904.2      x54  2575.86
 x7  2849.35     x19  2433.07     x31  1707.19     x43  5051.8      x55 11681.7
 x8    0        x20   765.09     x32  2064.72     x44  2648.57     x56  3426.14
 x9  2126.94     x21  1369.51     x33  2196.64     x45  6491.66     x57  8235.03
x10  3355.16     x22   197.946    x34  4386.9      x46  2880.43     x58  1632.2
x11  4983.35     x23  5845.12     x35     0        x47  3160.92     x59  1040.57
x12  2393.9      x24  8637.52     x36  2445.61     x48   107.063    x60  3165.56


b0=10499.5
b1=4.54885
b2=123.354
```

Exercise 3):

Q4)(R)

```
ampl: display _nvars;
_nvars = 30

ampl: display _ncons;
_ncons = 41

ampl: display _snzcons;
_snzcons = 36

ampl:
```

No of variables: 30

No of constraints: 41

No of non zeros in the constraints: 36

Q5)(R)

AMPL

```
ampl: include ex3.run;
Gurobi 8.0.0: optimal solution; objective 10692
13 simplex iterations
hours [*,*]
:  FRI MON THU TUE WED    :=
DH   0   0   6   2   0
HB   4   4   0   7   4
KC   3   4   0   0   2
KS   0   1   3   0   3
NK   2   0   5   0   0
SC   5   5   0   5   5
;

:   con1.body con1.lb con1.ub    :=
FRI     14       14      14
MON     14       14      14
THU     14       14      14
TUE     14       14      14
WED     14       14      14
;

:  con2.body con2.lb   con2.ub     :=
DH      8        8     Infinity
HB     19        8     Infinity
KC      9        8     Infinity
KS      7        7     Infinity
NK      7        7     Infinity
SC     20        8     Infinity
;

:      con3.body    con3.lb  con3.ub    :=
DH FRI      0      -Infinity     0
DH MON      0      -Infinity     0
DH THU      6      -Infinity     6
DH TUE      2      -Infinity     6
DH WED      0      -Infinity     0
HB FRI      4      -Infinity     4
```

```
HB MON      4      -Infinity     4
HB THU      0      -Infinity     0
HB TUE      7      -Infinity     8
HB WED      4      -Infinity     4
KC FRI      3      -Infinity     6
KC MON      4      -Infinity     6
KC THU      0      -Infinity     0
KC TUE      0      -Infinity     0
KC WED      2      -Infinity     6
KS FRI      0      -Infinity     0
KS MON      1      -Infinity     3
KS THU      3      -Infinity     8
KS TUE      0      -Infinity     0
KS WED      3      -Infinity     3
NK FRI      2      -Infinity     2
NK MON      0      -Infinity     0
NK THU      5      -Infinity     6
NK TUE      0      -Infinity     0
NK WED      0      -Infinity     0
SC FRI      5      -Infinity     5
SC MON      5      -Infinity     5
SC THU      0      -Infinity     0
SC TUE      5      -Infinity     5
SC WED      5      -Infinity     5
;

cost = 10692
```

1) The optimal solution came out to be:10692

2) The values are variables at optimal solution is:

Hours:

	FRI	MON	THU	TUE	WED
DH	**0**	**0**	**6**	**2**	**0**
HB	**4**	**4**	**0**	**7**	**4**
KC	**3**	**4**	**0**	**0**	**2**
KS	**0**	**1**	**3**	**0**	**3**
NK	**2**	**0**	**5**	**0**	**0**
SC	**5**	**5**	**0**	**5**	**5**

Exercise 4):

Q1)(R) 10 available alloys are: A1, A2,,A3,A4,A5,A6,A7,A8,A9 A10

Let x1=quantity of A1 coming from in house stock.
x2=quantity of A2 coming from in house stock.
x3=quantity of A3 coming from in house stock.
x4=quantity of A4 coming from in house stock.
x5=quantity of A5 coming from in house stock.
x6=quantity of A6 coming from in house stock.
x7=quantity of A7 coming from in house stock.
x8=quantity of A8 coming from in house stock.
x9=quantity of A9 coming from in house stock.
x10=quantity of A10 coming from in house stock.
Where 0<=x1<= 10,0<= x2<= 10,0<= x3= 0,0<= x4<= 8,0<= x5<= 15, 0<= x6<= 15,0<= x7<= 12,0<= x8<= 10,0<= x9<= 10,0<= x10<= 9;

Let y1 = quantity of A1 coming from market.
y2 = quantity of A2 coming from market.
y3 = quantity of A3 coming from market.
y4 = quantity of A4 coming from market.
y5 = quantity of A5 coming from market.
y6 = quantity of A6 coming from market.
y7 = quantity of A7 coming from market.
y8 = quantity of A8 coming from market.
y9 = quantity of A9 coming from market.
y10 = quantity of A10 coming from market.
Where yi>=0 for each i from 1-10

The optimal function will be :=
Minimize cost:
35*x1+50*x2+58*x3+60*x4+44*x5+39*x6+45*x7+55*x8+35

*x9+40*x10+72y*1+95*y2+110*y3+125*y4+88*y5+74*y6+95*y7+115*y8+60*y9+84*y10.

Our constraints are:

(The total output) The constraint 1 is :

x1+x2+x3+x4+x5+x6+x7+x8+x9+x10+y1+y2+y3+y4+y5+y6+y7+y8+y9+y10 = 100;

(The total composition of Chromium) The constraint 2 is :

0.8(x1+y1)+0.75(x2+y2)+0.75(x3+y3)+0.6(x4+y4)+0.55(x5+y5)+0.55(x6+y6)+0.4(x7+y7)+0.35(x8+y8)+0.3(x9+y9)+0.3(x10+y10) = 40;

(The total composition of Zinc) The constraint 3 is :

0.15(x1+y1)+0.15(x2+y2)+0.10(x3+y3)+0.20(x4+y4)+0.25(x5+y5)+0.10(x6+y6)+0.50(x7+y7)+0.15(x8+y8)+0.30(x9+y9)+0.55(x10+y10) = 35;

(The total composition of Copper) The constraint 4 is :

0.05(x1+y1)+0.1(x2+y2)+0.15(x3+y3)+0.2(x4+y4)+0.2(x5+y5)+0.35(x6+y6)+0.1(x7+y7)+0.5(x8+y8)+0.4(x9+y9)+0.15(x10+y10) = 25;

Q3)(R)

AMPL

```
ampl: include ex4.run;
Gurobi 8.0.0: optimal solution; objective 5149.24
5 simplex iterations
:      x       y      :=
A1    10       0
A10    9      10.56
A2     0       0
A3     0       0
A4     0       0
A5    15       0
A6     0.2     0
A7    12       0
A8     0       0
A9    10      33.24
;

:   con1.body    con1.lb  con1.ub    :=
A1     10        -Infinity    10
A10     9        -Infinity     9
A2      0        -Infinity    12
A3      0        -Infinity     0
A4      0        -Infinity     8
A5     15        -Infinity    15
A6      0.2      -Infinity    15
A7     12        -Infinity    12
A8      0        -Infinity    10
A9     10        -Infinity    10
;

con2.body = 100
con2.lb = 100
con2.ub = 100

cost = 5149.24
```

1) The optimal solution came out to be:5149.24

2) The values are variables at optimal solution is:

x1=10 y1= 0

x2=9 y2=10.56

x3=0 y30

x4=0 y4= 0

x5=0 y5= 0

x6=15 y6= 0

x7=.2 y7=0

x8=12 y8=0

x9=0 y9= 0

x10=10 y10= 33.24