a) 1. Let us assume the number of fulltime workers in the three shifts be x1, x2 and x3, which means

Number of FT workers in 8am-4pm=x1

Number of FT workers in 12pm-8pm=x2

Number of FT workers in 4pm-12am=x3

Now for each of the four hour shifts the number of part time workers be y1, y2, y3, y4, which means

Number of PT workers in 8am-12pm=y1

Number of PT workers in 12pm-4pm=y2

Number of PT workers in 4pm-8pm=y3

Number of PT workers in 8pm-12am=y4

Minimize:

C: ($14/hr.) (8hrs) [x1+x2+x3] + ($12/hr.) (4hrs) [y1+y2+y3+y4]

s.t.

x1+y1 ≥ 4

x1+x2+y2 ≥8

x2+x3+y3 ≥10

x3+y4 ≥6

for 1 PT 1FT is must on duty

x1 ≥ y1

x1+x2 ≥y2

x2+x3 ≥y3

x3 ≥y4

x1 ≥ 0, x2 ≥0, x3 ≥0, y1 ≥0, ≥y2, ≥y3 ≥0, y4 ≥0

1b) For minimum cost and 1:1 ratio on duty and mandatory lunch break

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Shift | F.T. starting | F.T. continues | P.T. | Minimum hrs. |
| 8-12 | 2(x1) |  | 2(y1) | 4 |
| 12-4 | 4(x2) | 2(x1) | 2(y2) | 8 |
| 4-8 | 3(x3) | 4(x2) | 3(y3) | 10 |
| 8-12 |  | 3(x3) | 3(y3) | 6 |

if full time employee takes 1hr. break

Minimize cost:

C:

($14/hr.) (8hrs) [x1+x2+x3] – ($14/hr.)[X1+X2+X3] +($12/hr.) (4hrs) [y1+y2+y3+y4]

2) c= Number of collegiate to produce

m= number of minis to produce

Maximize total profit= $32c + 24m

Nylon: 3c + 2m ≤5400 sq. foot

Labor: (3/4)c +(2/3)m ≤1400 hours (35 hours =40 labors)

(Total hours = 1400 hours)

The final constraint is that they should not produce more minis and collegiate than sales forecast

Sales forecast: c ≤1000

m ≤1200

and,

c ≥ 0

m ≥ 0

Let c = no of collegiate to produce

Let m = no of minis to produce

Maximum total profit = $32c + $24m

s.t. nylon: 3c + 2m ≤ 5400sq foot

labor hour: (3/4)c + (2/3)m ≤ 1400 hours

Sales forecast c ≤ 1000

m ≤1200

c ≥ 0

m ≥ 0

Let’s start by plotting a graph with Collegiates (c) on the horizontal axis and Minis (m) on the vertical axis, as shown below.

Constraint: -

For the Nylon constraint boundary line 3c + 2m = 5400 setting m = 0 yields a c-intercept of 1800 while setting c = 0 yields an m-intercept of 2700.

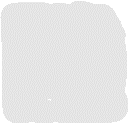
For the Labor constraint boundary line (3/4)c + (2/3)m = 1400 setting m = 0 yields a c-intercept of 1866.67 while setting c = 0 yields an m-intercept of 2100.

The sales forecast constraints are a horizontal line at m = 1200 and a vertical line at c = 1000. These constraint boundary lines are plotted below.

A feasible solution must be below or to the left of all four of the constraints above the c axis since c ≥ 0 and to the right of the m axis since m ≥ 0

The feasible solution that maximizes profit is $55,400, and the objective function line intersect the feasible region at the single point with (c,m) = (1000, 975) as shown below.

Therefore, the optimal solution is to produce 1000 Collegiates and 975 Minis, yielding a total profit of $55,400.



**3 a) Define the decision variables**

XP1L= number of large units produced at Plant 1,

       XP1M= number of medium units produced at Plant 1,

         XP1S= number of small units produced at Plant 1,

         XP2L= number of large units produced at Plant 2,

       XP2M= number of medium units produced at Plant 2,

         XP2S= number of small units produced at Plant 2,

         XP3L= number of large units produced at Plant 3,

       XP3M= number of medium units produced at Plant 3,

         XP3S= number of small units produced at Plant 3.

1. **Formulate a linear programming model for this problem.**

Maximize P = 420 XP1L + 360 XP1M + 300 XP1S + 420 XP2L + 360 XP2M + 300 XP2S

+ 420 XP2L+ 360 XP2M + 300 XP2S

St XP1L + XP1M + XP1S  ≤ 750

XP2L + XP2M + XP2S  ≤ 900

XP3L + XP3M + XP3S  ≤ 450

20 XP1L + 15 XP1M + 12 XP1S  ≤ 13000

20 XP2L + 15 XP2M + 12 XP2S  ≤ 12000

20 XP1L + 15 XP1L + 12 XP1L  ≤ 5000

XP1L + XP1M + XP1S  ≤ 900

XP2L + XP2M + XP2S  ≤ 1200

XP3L + XP3M + XP3S  ≤ 750

 (XP1L + XP1M + XP1S) - ( XP2L + XP2M + XP2S) = 0

(XP1L + XP1M + XP1S) - ( XP3L +XP3M + XP3S) = 0

XP1L ≥ 0, XP1M ≥ 0, XP1S ≥ 0, XP2L ≥ 0, XP2M ≥ 0, XP2S ≥ 0,

XP3L ≥ 0, XP3M ≥ 0, XP3S ≥ 0

c) **Solve the problem using lpsolve, or any other equivalent library in R.**

please find attached r file.