1. A)

Lets assume that full time employees in all the shifts (morning, afternoon and evening)are X1, X2 and X3

Other assumptions are,

part time employees during 8am to noon= y1

part time employees during noon to 4pm= y2

part time employees during 4pm to 8pm= y3

part time employees during 8pm to midnight= y4

Problem says that,

Minimum number of employees working from 8am to noon=4

So, x1+y1>=4

Likewise,

X1+x2+y2>=8

X2+x3+y3>=10

X3+y4>=6

X1>=y1 (8am to noon)

X1+x2>=y2 (noon to 4pm )

X2+x3>=y3 (4pm to 8pm )

X3>=y4 (8pm to midnight)

Fulltime employees earn in a day= 14\*8= $112

And part timers earn= 12\*4= $48

Hence cost function would be = 112\*(x1+x2+x3) + 48\*(y1+y2+y3+y4)

One full time employee should be there in all the shifts, so, the min number of full-time employees required is 28/4= 7

Thus,

X1+y1+x1+x2+y2+x2+x3+y3+x3+y4>=28

2(x1+x2+x3) + (y1+y2+y3+y4)>=28

2\*7 + (y1+y2+y3+y4)>=28

As such, part time employees should be >=14

Minimum cost would be = 112\*7 + 48\*14= 784 + 672= $1456

B)

For fulltime employees there is a one hour break in the 8 hour shift and no break for part time employees.

Lunch time for Full- time consultants can start at 3rdhr or 4th hr.

So Minimum cost function is ,

Min= 8\*14(F1 + F2 + F3) -14\*(F1 + F2 + F3) + 4\*12(P1 + P2 + P3 + P4).

(P1 means Full time and P is part time)

Hence it would be

Min = 112(2+2+3) – 14(2+2+3) +4\*12(2+4+5+3)

= 1358

Therefore, 1456 (from A above)– 1358 = 98

1. say the number of collegiate backpacks produced= x  
   and mini backpacks produced= y  
   Total profit z= 32x + 24y  
   Total nylon fabric required= 3x + 2y  
   Therefore, 3x + 2y<= 5000

Further, x<=1000 and y<=1200 AND   
Total labor required= 45x + 40y  
Available labor= 35\*40\*60= 84000 minutes  
Thus, 45x + 40y <=84000

Formulating the LP based on the info:

Maximize say Z= 32x + 24y  
and the constraints are,

3x + 2y<=5000  
 X<=1000  
 Y<=1200  
 45x + 40y<=84000  
 X, y>=0

Please find the xls file (separate one) , depicting the graphical solution

3.

Say the number of large products by plant 1 is X1 and X2 & X3 for other plants

Say the number of medium products by plant 1 is Y1 and Y2 & Y3 for other plants

Say the number of small products by plant 1 is Z1 and Z2 & Z3 for other plants

The decision variables are as below:

X1+Y1+Z1<=750

X2+Y2+Z2<=900

X3+Y3+Z3<=450

20X1+15Y1+12Z1<=13000

20X2+15Y2+12Z2<=12000

20X3+15Y3+12Z3<=5000

X1+X2+X3<=900

Y1+Y2+Y3<=1200

Z1+Z2+Z3<=7500

And, X1, X2, X3, Y1, Y2, Y3, Z1, Z2, Z3>=0