1. Decision Variables = 25

x_{ij} $i \geq 1$ $j \leq 5$

Decision Variables $\rightarrow$ Binary (0 or 1)
1 $\rightarrow$ when person i is doing task j
otherwise 0.

Taking input cost matrix as variable cost
$Cost_{ij} \rightarrow$ Cost for person i doing task j.

OBJECTIVE FUNCTION

minimize: $\sum\sum cost(ij) \times x_{(ij)}$ (for $i \geq 1$ & $j \leq 5$)

CONSTRAINTS

$\sum x_{ij} = 1$ $\forall$ $i \in \{1,2,3,4,5\}$ (j fixed)
$\sum x_{ij} = 1$ $\forall$ $j \in \{1,2,3,4,5\}$ (i fixed)

Sum of rows & columns of decision variable
matrix = 1.

OUTPUT MATRIX

$$\begin{bmatrix} 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Interpretation : Person 4 is doing task 1
Person 3 is doing task 2
Person 1 is doing task 3

Person 2 is doing task 4
Person 5 is doing task 5
Accordingly, min^m. cost = 40 + 39 + 43 + 45 + 43
$$= ₹ 210$$

2. Decision Variables = 9 (integers)

✎ OBJECTIVE FUNCTION:

Maximize: $\sum [\text{Profit} \times \{\Sigma P_{ij}?\}]$ $i \in \{1,2,3\}$ $j \in \{\text{Heavy Duty, Standard Economy}\}$

CONSTRAINTS

Sum of total battries & lead used in each plant has to be < limits.

Total prod^n. < Total demand of same type.

Total Batteries:

$P_i\_HeavyD + P_i\_Standard + P_i\_Economy \leq 8 AC_i$
where $i \in \{1, 2, 3\}$ & $AC_1 = 550$, $AC_2 = 750$, $AC_3 = 225$

Total leads used :

$\underset{\text{HeavyDemand}}{\underbrace{LeadR\_HD \times P_i\cdot HD}} + \underset{\text{Standard}}{\underbrace{LeadR\_Stan \times P_i Stan}} + \underset{\substack{\text{Economy} \\ \leq \text{Max. lead} \\ \text{Prod}(i).}}{\underbrace{LeadR\_E \times P_i E}}$

Total Demand:

~~$P_i\_HeavyD + P_i\_Standard + P_i\_$~~
$P_1\_HeavyD + P_2\_HeavyD + P_3\_HeavyD \leq 700$
Similar for other 2 as well.

OUTPUT

$$\begin{bmatrix} 171 & 377 & 0 \\ 16 & 392 & 0 \\ 98 & 126 & 0 \end{bmatrix}$$

=> COMPANY DOES NOT PRODUCE ANY ECONOMY BATTERY

INTERPRETATION

Plant 1 Produces 171 H&D, 377 Standard & 0 Economy Batteries.

Plant 2 produces 16 HD, 392 Standard & 0 Economy Batteries.

Plant 3 produces 98 HD, 126 Standard & 0 Economy Batteries.

b).

CONSTRAINT

In addition to 2a. above constraints:

$$\xi\, P_{economy} \geq 0.4 \times (\xi(P_{economy} + P_{standard} + P_{HD}))$$

OUTPUT

$$\begin{bmatrix} 476 & 0 & 0 \\ 0 & 0 & 450 \\ 199 & 0 & 0 \end{bmatrix}$$

=> COMPANY DOES NOT PRODUCE ANY STANDARD BATTERY

INTERPRETATION

Plant 1 produces only 476 HD batteries.

Plant 2 ———"———— 450 Economy —"—

Plant 3 ——— "——— 199 HD batteries.