Assignment 1

	Materials required	Profit/unit	Time required
Collegiate →	3 sq.ft	$32	45 mins
Minis →	2 sq.ft	$24	40 mins

→ Total materials availabc = 5000 sqft.

→ Total available hours of labour/week = Total employees * No. of hours each employee works/week

$$= 35 \times 40 = 1400 \text{ hours}$$

⟹ Let P be the total profit

    C be the no. of collegiate manufactured

    M be the no of Minis manufactured

$\therefore$ Maximize $(P) = 32 * C + 24 * M$

$$0 \leq C \leq 1000$$
$$0 \leq M \leq 1200$$

✱ Material constraints:

$$3C + 2M \leq 5000$$

✱ Time constraints:

$$\frac{3}{4}C + \frac{2M}{3} \leq 1400$$

45 mins → hours
$$= \frac{45}{60} = \frac{3}{4} \text{hr}$$

40 mins → hours
$$= \frac{40}{60} = \frac{2}{3} \text{hr}$$

(A) Decision variable

P = Total profit

C = no. of collegiate manufactured

M = no of Minis manufactured

1) Objective function

(b) Mathematical Formulation

Maximize $(P) = 32 * C + 24 * M$

subject to

2) Constraints

$$3C + 2M \leq 5000 \quad (\text{material constraints})$$

$$\frac{3}{4}C + \frac{2}{3}M \leq 1400 \quad (\text{time constraints})$$

$$0 \leq C \leq 1000$$
$$0 \leq M \leq 1200$$

$\Big\}$ Sales forecast limit for collegiate & Minis)

(Non-negativity of decision variables)

① Mathematical Formulation

Maximize $(P) = 32 * C + 24 * M$ (objective function)

subject to

$3C + 2M \leq 5000$ (material constraints)

$\frac{3}{4}C + \frac{2}{3}M \leq 1400$ (time constraints)

$0 \leq C \leq 1000$ { sales forecast limit,

$0 \leq M \leq 1200$ (non-negativity of decision variables)

Plant	Excess capacity	Storage space
Plant 1	750 units / day	13,000 sq.ft
Plant 2	900 units / day	12,000 sq.ft
Plant 3	450 units / day	5000 sq.ft

Plant size	Profit/unit	Material/unit	Sales/day
Large	$420	20 sq.ft	900
Medium	$360	15 sq.ft	1200
Small	$300	12 sq.ft	750

Let N = no. of units produced

consider $N(x, y)$

where $x = (1, 2, 3) \rightarrow$ Plant number

$y = (L, M, S) \rightarrow$ size of product produced.

for eg:

N_2M = no. of units of medium products produced in plant 2

Objective function

let P = profit

Maximize $P = 420 (N_1L + N_2L + N_3L) + 360 (N_1M + N_2M + N_3M)$
$+ 300 (N_1S + N_2S + N_3S)$

$N_1L \Rightarrow$ no. of units of large product in Plant ①

$N_2L \Rightarrow$ " plant ②

$N_3L \Rightarrow$ " plant ③

$N_1M \Rightarrow$ no. of units of medium product produced in plant ①

$N_2M \Rightarrow$ " plant ②

$N_3M \Rightarrow$ " plant ③

$N_1S \Rightarrow$ no. of units of small product produced in plant ①

$N_2S \Rightarrow$ " plant ②

$N_3S \Rightarrow$ " plant ③

where $N(x, y) \rightarrow$

$N_{xy} \geq 0$

(non-negativity constraints)

Constraints

① Excess capacity constraints

Plant ① $\Rightarrow N_{1L} + N_{1m} + N_{1s} \leq 750$ (for plant 1)

Plant ② $\Rightarrow N_{2L} + N_{2m} + N_{2s} \leq 900$

Plant ③ $\Rightarrow N_{3L} + N_{3m} + N_{3s} \leq 450$

② Space constraints

Plant ① $\Rightarrow 20 N_{1L} + 15 N_{1m} + 12 N_{1s} \leq 13,000$

Plant ② $\Rightarrow 20 N_{2L} + 15 N_{2m} + 12 N_{2s} \leq 12,000$

Plant ③ $\Rightarrow 20 N_{3L} + 15 N_{3m} + 12 N_{3s} \leq 5000$

③ Sales as per forecast

Plant ① $\Rightarrow N_{1L} + N_{1m} + N_{1s} \leq 900$

Plant ② $\Rightarrow N_{2L} + N_{2m} + N_{2s} \leq 1200$

Plant ③ $\Rightarrow N_{3L} + N_{3m} + N_{3s} \leq 750$

④ Percentage of excess capacity to avoid layoffs

Plant ① $\Rightarrow \dfrac{N_{1L} + N_{1m} + N_{1s}}{750} \times 100$

Plant ② $\Rightarrow \dfrac{N_{2L} + N_{2m} + N_{3s}}{900} \times 100$

Plant ③ $\Rightarrow \dfrac{N_{3L} + N_{3m} + N_{3s}}{450} \times 100$