IE 7200 HW-2

1. **(50 pts) Chapter 5, exercise 2 on page 134.**

Solution:

Objective Function: $$Min \sum_{i=1}^{n} F_i Xi + \sum_{i=1}^{n} \sum_{j=1}^{m} c_{ij} k_{ij}$$

Subject to,

$$\sum_{i=1}^{n} k_{ij} = D_j \qquad \sum_{j=1}^{m} k_{ij} = P_i X_i$$

, where, $i = (1,...,n)$ and $j = (1,...,m)$; $X_i \in \{0,1\}$; and $k_i \square >= 0$

m denotes the total number of demand centers or markets.

n represents the total count of possible plant sites along with their capacities.

P_i indicates the potential production capacity of plant i.

$D\square$ signifies the annual demand originating from market j.

F_i is the annual fixed cost associated with maintaining plant i operational.

$c_i\square$ refers to the expense incurred for producing and transporting a single unit from plant i to market j, covering production, inventory, and shipping costs.

X_i equals 1 if plant i is in operation, otherwise it's 0.

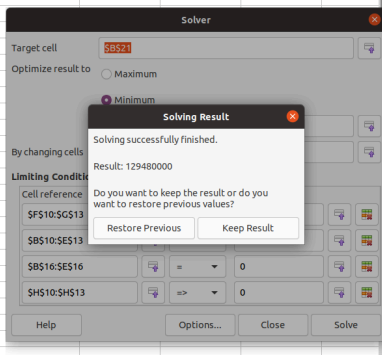
$k_i\square$ represents the number of products shipped from plant i to market j.

	East	South	Midwest	West	Fixed Cost	Low Capacity	Fixed Cost	High Capacity
New York	211	232	240	300	6000000	200000	10000000	400000
Atlanta	232	212	230	280	5500000	200000	9200000	400000
Chicago	238	230	215	270	5600000	200000	9300000	400000
San Diego	299	280	270	225	6100000	200000	10200000	400000
Demand	110000	180000	120000	100000				

	East	South	Midwest	West	Low	High	Excess capacity
New York	0	0	0	0	0	0	0
Atlanta	110000	180000	110000	0	0	1	0
Chicago	0	0	0	0	0	0	0
San Diego	0	0	10000	100000	1	0	90000

	East	South	Midwest	West
Unmet Demand	0	0	0	0

Objective Function:	
Fixed Cost	15300000
Variable Cost	114180000
Total Cost	129480000



Building facilities in Atlanta, which can accommodate 400,000 units, and in San Diego, which can accommodate 200,000 units, is the most financially sound course of action, according to the Excel Solver analysis. This

configuration efficiently satisfies demand at an annual total cost of approximately **$129,480,000**. This figure captures all relevant costs related to manufacturing, distribution, plant operations, and inventory management, proving that this strategy is the best way to cut costs without sacrificing market demand.

2. **(50 pts) Chapter 5, exercise 3 on page 134-5.**

Solution: Part (a)

Objective Function: $$Min \sum_{i=1}^{n} F_i Xi + \sum_{i=1}^{n} \sum_{j=1}^{m} c_{ij} k_{ij}$$

Subject to,

$$\sum_{i=1}^{n} k_{ij} = D_j \qquad \sum_{i=1}^{n} k_{ij} \leq P_i \qquad \sum_{i=1}^{n} k_{ij} \geq 0.5 P_i$$

, where, $i = (1,...,n)$ and $j = (1,...,m)$; $X_i \in \{0,1\}$; and $k_i \square >= 0$

		North America	Europe	Japan	South America	Asia	Production Cost	Production cost (Local currency)	Exchange Rate ($)	Plant Capacity
2	US	600	1300	2000	1200	1700	10000	10000	1	185
3	Germany	1300	600	1400	1400	1300	7530	15000	0.502	475
4	Japan	2000	1400	300	2100	900	16740	1800000	0.0093	50
5	Brazil	1200	1400	2100	800	2100	7306	13000	0.562	200
6	India	2200	1300	1000	2300	800	9200	400000	0.023	80
7	Demand	270	200	120	190	100				

		North America	Europe	Japan	South America	Asia	Plant Capacity	Capacity at 50%
10	US	100	0	0	0	0	100	92.5
11	Germany	160	200	95	0	20	475	237.5
12	Japan	0	0	25	0	0	25	25
13	Brazil	10	0	0	190	0	200	100
14	India	0	0	0	0	80	80	40

		North America	Europe	Japan	South America	Asia
17	Unmet Demand	0	0	0	0	0

19	Objective Function:	
20	Cost	7974950

Part (b)

		North America	Europe	Japan	South America	Asia	Production Cost	Production cost (Local currency)	Exchange Rate ($)	Plant Capacity
2	US	600	1300	2000	1200	1700	10000	10000	1	185
3	Germany	1300	600	1400	1400	1300	7530	15000	0.502	475
4	Japan	2000	1400	300	2100	900	16740	1800000	0.0093	50
5	Brazil	1200	1400	2100	800	2100	7306	13000	0.562	200
6	India	2200	1300	1000	2300	800	9200	400000	0.023	80
7	Demand	270	200	120	190	100				

		North America	Europe	Japan	South America	Asia	Plant Capacity
10	US	125	0	0	0	0	125
11	Germany	135	200	120	0	20	475
12	Japan	0	0	0	0	0	0
13	Brazil	10	0	0	190	0	200
14	India	0	0	0	0	80	80

		North America	Europe	Japan	South America	Asia
17	Unmet Demand	0	0	0	0	0

19	Objective Function:	
20	Cost	7816450

Part (c)

Enhancing a plant's capacity by 10 tons can effectively alleviate production constraints, leading to a more significant reduction in total production costs. For instance, by increasing the capacity of the plant in India from 200 tons to 210 tons, the overall production expenses are reduced by $20,940, moving from $7,816,450 to $7,795,510.

	A	B	C	D	E	F	G	H	I	J	K
1		North America	Europe	Japan	South America	Asia	Production Cost	Production cost (Local currency)	Exchange Rate ($)	Plant Capacity	
2	US	600	1300	2000	1200	1700	10000	10000	1	185	
3	Germany	1300	600	1400	1400	1300	7530	15000	0.502	475	
4	Japan	2000	1400	300	2100	900	16740	1800000	0.0093	50	
5	Brazil	1200	1400	2100	800	2100	7306	13000	0.562	210	
6	India	2200	1300	1000	2300	800	9200	400000	0.023	80	
7	Demand	270	200	120	190	100					
8											
9		North America	Europe	Japan	South America	Asia	Plant Capacity				
10	US	115	0	0	0	0	115				
11	Germany	135	200	120	0	20	475		10 tons of capacity added to India		
12	Japan	0	0	0	0	0	0				
13	Brazil	20	0	0	190	0	210				
14	India	0	0	0	0	80	80				
15											
16		North America	Europe	Japan	South America	Asia					
17	Unmet Demand	0	0	0	0	0					
18											
19	Objective Function:										
20	Cost	7795510									
21											

Part (d)

Variations in currency exchange rates have the potential to significantly influence the operational costs at Sunchem's manufacturing sites. To navigate these fluctuations effectively, Sunchem could adopt a strategic approach by reallocating production among its plants in response to advantageous exchange rate movements. This tactic allows Sunchem to leverage currency valuations to optimize costs. However, implementing this strategy effectively requires the company to design its plants with surplus capacity. This additional capacity ensures that Sunchem can quickly and efficiently shift production volumes without encountering constraints, thereby maximizing operational flexibility and cost efficiency in the face of exchange rate variability.