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Suggested Solution for Case Study 2

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1. (a) The model is given in solution of hw2. Check the AMPL model file "case2-1.mod" and data file "case2-1.dat". After solving, the objective value is 9 and we get $x^* = (0, 1, 1, 0)$
2. (a) Let the parameters be

I = the number of fabs, that is 8,
 J = the number of items, that is 12,
 K = the number of orders, that is 10,
 R_k = Revenue from order k if it's completed, $k = 1, \dots, K$,
 H_{ij} = the production rate that Fab i produces item j , $i = 1, \dots, I$, $j = 1, \dots, J$,
 Q_{jk} = the demand quantity of item j in Order k , $j = 1, \dots, J$, $k = 1, \dots, K$,
 C_i = the capacity of Fab i , $i = 1, \dots, I$.

Let the decision variables be

x_{ijk} = the production hour that Fab i produces item j in order k , $i = 1, \dots, I$, $j = 1, \dots, J$, $k = 1, \dots, K$,
 $y_k = \begin{cases} 1 & \text{if the order } k \text{ is completed} \\ 0 & \text{otherwise} \end{cases}, k = 1, \dots, K.$

$$\begin{aligned} \max \quad & \sum_{k=1}^K (R_k y_k) \\ \text{s.t.} \quad & \sum_{k=1}^K \sum_{j=1}^J x_{ijk} \leq C_i \quad \forall i = 1, \dots, I \\ & \sum_{i=1}^I x_{ijk} H_{ij} \geq Q_{jk} y_k \quad \forall k = 1, \dots, K, j = 1, \dots, J \\ & x_{ijk} \geq 0 \quad \forall i = 1, \dots, I, j = 1, \dots, J, k = 1, \dots, K \\ & y_k \in \{1, 0\} \quad \forall k = 1, \dots, K. \end{aligned}$$

- (b) Check the AMPL model file "case2-2.mod" and data file "case2-2.dat". After solving, the maximum profit is 70900 and we get

Fab1

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	80	150	0	0	0
4	0	0	0	0	0	0	0	0	200	0	0	0
5	0	0	0	0	0	0	0	0	62.5	0	0	0
6	0	0	0	0	0	0	0	60	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	200	0	0	0	0	0	0	0	0	0	0	0
9	7.5	0	0	0	0	0	0	40	0	0	0	0
10	0	0	0	0	0	0	0	40	0	0	0	0
											sum	840

Fab2

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	200	0	0
2	0	0	0	0	0	0	0	0	0	0	150	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	60	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	80	0	0
9	0	0	115	0	0	0	0	0	25	120	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	750

Fab3

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	50	0	0	0	0	0	0	0	0	0
4	0	200	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	34.167	116.667	0	0	0	0	0	0	0	0	0
7	0	50	16.667	0	0	0	0	0	0	0	0	0
8	0	100	0	0	0	0	0	0	0	0	0	0
9	0	0	42.5	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	610

Fab4

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	9.2667	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	21.5667	0	0
5	0	0	0	0	60	62.5	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	50	0
7	0	0	0	0	0	125	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	100	0
9	0	0	0	0	0	25	0	0	0	0	16.667	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	470

Fab5

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	166.667	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	235	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	25
8	0	0	0	0	0	0	33.333	0	0	0	0	0
9	0	0	0	0	0	0	100	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	560

Fab6

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	19.2083	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	68.5	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	30	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	20	0	0	0	0	0	0	0
9	35.625	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	66.667	0	0
											sum	240

Fab7

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	200	0	0	0	0	0	0	0
2	0	400	0	0	0	200	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	90.2	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	63.333	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	196.467	0	0	0	0	0	0	0	100
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	<u>1250</u>

Fab8

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	66.667	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	100
4	0	0	0	0	105	0	0	0	0	0	0	150
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	133.333	33.333	0	0	0	0	0	0	75
10	0	0	0	66.667	0	0	0	0	0	0	0	200
											sum	<u>930</u>

3. (a) Let the parameters be

I = the number of fabs, that is 8,

J = the number of items, that is 12,

K = the number of orders, that is 10,

S_k = the splitting costs of order k , $k = 1, \dots, K$,

R_k = Revenue from order k if it's completed, $k = 1, \dots, K$,

H_{ij} = the production rate that Fab i produces item j , $i = 1, \dots, I$, $j = 1, \dots, J$,

Q_{jk} = the demand quantity of item j in Order k , $j = 1, \dots, J$, $k = 1, \dots, k$,

C_i = the capacity of Fab i , $i = 1, \dots, I$.

Let the decision variables be

x_{ijk} = the production hour that Fab i produces item j in order k , $i = 1, \dots, I$, $j = 1, \dots, J$, $k = 1, \dots, K$,

$y_k = \begin{cases} 1 & \text{if the order } k \text{ is completed} \\ 0 & \text{otherwise} \end{cases}, k = 1, \dots, K,$

$z_{ik} = \begin{cases} 1 & \text{if fab } i \text{ produces for order } k \\ 0 & \text{otherwise} \end{cases}, i = 1, \dots, I, k = 1, \dots, K.$

$$\begin{aligned} \max \quad & \sum_{k=1}^K \left(R_k y_k - \left(\sum_{i=1}^I z_{ik} - y_k \right) S_k \right) \\ \text{s.t.} \quad & \sum_{k=1}^K \sum_{j=1}^J x_{ijk} \leq C_i \quad \forall i = 1, \dots, I \\ & \sum_{i=1}^I x_{ijk} H_{ij} \geq Q_{jk} y_k \quad \forall k = 1, \dots, K, j = 1, \dots, J \\ & \sum_{j=1}^J x_{ijk} H_{ij} \leq z_{ik} \sum_{j=1}^J Q_{jk} \quad \forall i = 1, \dots, I, k = 1, \dots, K \\ & x_{ijk} \geq 0 \quad \forall i = 1, \dots, I, j = 1, \dots, J, k = 1, \dots, K \\ & y_k \in \{1, 0\} \quad \forall k = 1, \dots, K \\ & z_{ik} \in \{1, 0\} \quad \forall i = 1, \dots, I, k = 1, \dots, K. \end{aligned}$$

(b) Check the AMPL model file "case2-3.mod" and data file "case2-3.dat". After solving, the maximum profit 50070 and we get

Fab1

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	250	80	150	0	0	0
4	0	0	0	0	0	0	0	0	200	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	15	85	0	0	0	60	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	840

Fab2

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	200	0	0	33.33	0	133.33	0	120	10	0
10	0	0	0	0	0	0	0	133.33	0	120	0	0
											sum	750

Fab3

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	50	0	0	0	0	0	0	0	0	66.667
4	0	200	0	0	0	0	0	0	0	0	0	48.333
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	50	111.667	0	0	0	0	0	0	0	0	0
7	0	50	16.667	0	0	0	0	0	0	0	0	16.667
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	610

Fab4

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	200	0	0	0	0	62.5	0	0	0	0	0	0
6	0	0	0	32.5	0	0	0	0	0	0	50	0
7	0	0	0	0	0	125	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	470

Fab5

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	100	133.33	0	0	0	0	33.333	0	0	62.778	0	0
9	75	0	0	0	0	55.556	100	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	<u>560</u>

Fab6

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	40	60	0	0	0	0	111.11	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	<u>211.11</u>

Fab7

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	333.33	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	133.33	155
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	50	66.667	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	211.667	200	100
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
											sum	<u>1250</u>

Fab8

order/item	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	100	0	0	0	125	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	133.33	33.33	0	0	0	25	0	60	75
10	0	0	0	66.667	0	0	0	0	0	0	0	200
											sum	<u>818.33</u>

4. omitted