# MODEL EXAM SOLUTIONS

## Solution for Question 1:

***Objective function:***

z (max) = 15,000x1 + 18,000x2 + 12,000x3 + 8,000x4

**Constraints:**

1. ***Chemical availability***:

20x1 + 10x2 <= 200 (s1)

10x2 <= 100 (s2)

15x2 + 10x3 <=150 (s3)

30x1 + 40x3 <= 500 (s4)

10x1 + 30x4 <=250 (s5)

30x4 <=50 (s6)

1. ***Government restriction on multivitamin:***

x4 >= 8 (needs modification)

-x4 <= -8 (s7)

1. ***Company’s production restriction:***

x1 + x2 + x3 + x4 <= 28; (s8)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UP** |  | ***15*** | ***18*** | ***12*** | ***8*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |  |
|  | **BM** | **x1** | **x2** | **x3** | **x4** | **s1** | **s2** | **s3** | **s4** | **s5** | **s6** | **s7** | **s8** | **SOL** |
| *0* | **s1** | 20 | 10 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 200 |
| *0* | **s2** | 0 | 10 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 100 |
| *0* | **s3** | 0 | 15 | 10 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 150 |
| *0* | **s4** | 30 | 0 | 40 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 500 |
| *0* | **s5** | 10 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 250 |
| *0* | **s6** | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 50 |
| *0* | **s7** | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -8 |
| *0* | **s8** | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 28 |

## Solution for Question 2

### Part 1: Demand of biscuits from Mekelle

Using regression analysis, it is expected to be around 350 tons.

### Part 2: Initial feasible solution using VAM

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **FACTORIES** | **DEALERS** | | | | ss |
| **Addis Ababa** | **Jimma** | **Bahir Dar** | **Mekelle** |
| **Dessie** | 14 | 9 (100) | 15 | 10 (100) | 200 |
| **Hawasa** | 11 (400) | 7 | 12 | 9 | 400 |
| **Gondar** | 14 (30) | 12 | 13 (20) | 11 (250) | 300 |
| **Adama** | 12 | 9 (100) | 13 | 12 | 100 |
| **Dummy** | 0 | 0 | 0 (50) | 0 | 50 |
| DD | 430 | 200 | 70 | 350 |  |

Transportation cost to be = **1,063,000 Birr**

### Part 3: Optimal feasible solution

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **FACTORIES** | **DEALERS** | | | | ss |
| **Addis Ababa** | **Jimma** | **Bahir Dar** | **Mekelle** |
| **Dessie** | 14 | 9 (130) | 15 | 10 (70) | 200 |
| **Hawasa** | 11 (400) | 7 | 12 | 9 | 400 |
| **Gondar** | 14 (0) | 12 | 13 (20) | 11 (280) | 300 |
| **Adama** | 12 (30) | 9 (70) | 13 | 12 | 100 |
| **Dummy** | 0 | 0 | 0 (50) | 0 | 50 |
| DD | 430 | 200 | 70 | 350 |  |

Transportation cost to be = **1,060,000 Birr**

## CASE ANALYSIS

### Solution Case 1 (a)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PAYOFF MATRIX** | | | | |
| **ALTERNATIVES** | **STATE OF NATURE** | | | |
| **1000 Cust** | **750 Cust** | **500 Cust** | **250 cust** |
| Self-operating | 150000 | 45000 | 0 | -25000 |
| Leasing | 45000 | 45000 | 45000 | 45000 |
| Contract | 75000 | 75000 | 25000 | 25000 |
| Do nothing | -10000 | -10000 | -10000 | -10000 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SIMPLIFIED PAYOFF MATRIX** | | | | |
| **ALTERNATIVES** | **STATE OF NATURE** | | | |
| **1000 Cust** | **750 Cust** | **500 Cust** | **250 cust** |
| Self-operating | 150 | 45 | 0 | -25 |
| Leasing | 45 | 45 | 45 | 45 |
| Contract | 75 | 75 | 25 | 25 |
| Do nothing | -10 | -10 | -10 | -10 |

### Solution Case 1 (b)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **OPTIMISTIC DECISION** |  |  |  |  |  |
| **ALTERNATIVES** | **STATE OF NATURE** |  |  |  | **ROWMAX** |
|  | **1000 Cust** | **750 Cust** | **500 Cust** | **250 cust** |  |
| Self-operating\*\* | 150 | 45 | 0 | -25 | 150 |
| Leasing | 45 | 45 | 45 | 45 | 45 |
| Contract | 75 | 75 | 25 | 25 | 75 |
| Do nothing | -10 | -10 | -10 | -10 | -10 |

### Solution Case 1 (c)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EXPECTED VALUE METHOD** |  |  |  |  |  |
| **ALTERNATIVES** | **STATE OF NATURE** |  |  |  | **EV** |
|  | **1000 Cust** | **750 Cust** | **500 Cust** | **250 cust** |  |
| Self-operating | 150 | 45 | 0 | -25 | 31 |
| Leasing | 45 | 45 | 45 | 45 | 45 |
| Contract \*\* | 75 | 75 | 25 | 25 | 47.5 |
| Do nothing | -10 | -10 | -10 | -10 | -10 |
| PRIOR PROBABILITIES | 0.15 | 0.3 | 0.35 | 0.2 |  |

### Solution Case 1 (d)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Maximum Likelihood Criterion** | |  |  |  |  |
| **ALTERNATIVES** | **STATE OF NATURE** | | | | **MAX Likelihood State (500 cust with 0.4 prob)** |
| **1000 Cust** | **750 Cust** | **500 Cust** | **250 cust** |
| Self-operating | 150 | 45 | 0 | -25 | 0 |
| Leasing \*\* | 45 | 45 | 45 | 45 | 45 |
| Contract | 75 | 75 | 25 | 25 | 25 |
| Do nothing | -10 | -10 | -10 | -10 | -10 |
| PRIOR PROBABILITIES | 0.2 | 0.3 | 0.4 | 0.1 |  |

### Solution Case 2 (a)

A

**10**

B

**6**

E

**15**

D

C

**8**

**12**

G

**3**

H

**18**

J

**5**

I

**2**

F

**6**

***Critical Path 4: A – E – H – J = 10 + 15 + 18 + 5***

***Project duration = 48 weeks***

Path 1: A – C – F – I = 10 + 8 + 6 + 2 = 26 weeks

Path 2: A – D – G – I = 10 + 12 + 3 + 2 = 27 weeks

Path 3: A – D – H – J = 10 + 12 + 18 + 5 = 45weeks

***Path 4: A – E – H – J = 10 + 15 + 18 + 5 = 48 weeks***

Path 5: A – E – G – I = 10 + 15 + 3 + 2 = 30 weeks

Path 6: B –E- G – I = 6 + 15 + 3 +2 = 26 weeks

Path 7: B – E – H – J = 6 + 15 + 18 + 5 = 44 weeks

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### Solution Case 2 (b)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ACTIVITIES** | **IMMEDIATE  PREDECESSOR(S)** | **NORMAL** | | **CRASH** | | **MAX CT** | **CC/W** |
| **DURATION  (WEEKS)** | **COST  (BIRR)** | **DURATION  (WEEKS)** | **COST  (BIRR)** |
| A\* | - | 10 | 2,00,000 | 8 | 2,20,000 | 2 | 10000 |
| B | - | 6 | 1,80,000 | 5 | 2,00,000 | 1 | 20000 |
| C | A | 8 | 3,20,000 | 5 | 3,35,000 | 3 | 5000 |
| D | A | 12 | 2,80,000 | 8 | 3,40,000 | 4 | 15000 |
| E\* | A,B | 15 | 3,20,000 | 15 | 3,20,000 | 0 | 0 |
| F | C | 6 | 80,000 | 5 | 82,000 | 1 | 2000 |
| G | D, E | 3 | 25,000 | 3 | 25,000 | 0 | 0 |
| H\* | D, E | 18 | 2,10,000 | 14 | 2,35,000 | 4 | 6250 |
| I | F, G | 2 | 20,000 | 2 | 20,000 | 0 | 0 |
| J\* | H | 5 | 1,25,000 | 3 | 1,40,000 | 2 | 7500 |

Activities involved in critical path with their MAX CT are: A (2) – E (0) – H (4) – J (2)

Total project duration = 48 weeks

Second longest path and their MAX CT are: A (2) – D (4) – H (4) – J (2)

Second longest path duration is 45 weeks.

To complete project within 44 weeks, it has to be crashed by 4 weeks. The activity with lowest CC/W is activity H and it is a common activity of both critical path and second longest path. Hence we can crash 4 weeks on activity H to get the project completed in 44 weeks.

### Solution Case 2 (c)

In normal condition the cost of the project would be: **17,60,000 Birr**

Additional cost for crashing 4 weeks = **25,000 Birr**

If crashed benefit = 10,000 x 4 = 40,000 Birr

If crashed the cost = 25,000 Birr

Net benefit of crashing by 4 weeks (completing the project in 44 weeks) = 40,000 – 25,000 = **15,000 Birr**