Appendix a

Linear programming Using THE EXCEL SOLVER

1. Excel Solution

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **X** | **Y** | **Total** |  |  |
| Decision | 6 | 0 |  |  |  |
| Profit | $3 | $1 | $18 |  |  |
|  |  |  |  |  |  |
|  |  |  | **Resources** |
|  | **X** | **Y** | **Used** |  | **Capacity** |
| A | 12 | 14 | 72 | <= | 85 |
| B | 3 | 2 | 18 | <= | 18 |
| C |  | 1 | 0 | <= | 4 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Graphical solution--the problem requested the Excel solution, but the following graphical solution is provided for classroom use if desired.



2.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **A** | **B** | **Total** |  |  |
| Decision | 15 | 10 |  |  |  |
| Cost | $2 | $4 | $70 |  |  |
|  |  |  |  |  |  |
|  |  |  | **Resources** |
|  | **A** | **B** | **Used** |  | **Capacity** |
| A | 4 | 6 | 120 | >= | 120 |
| B | 2 | 6 | 90 | >= | 72 |
| C |  | 1 | 10 | >= | 10 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Graphical solution--the problem requested the Excel solution, but the following graphical solution is provided for classroom use if desired.



3. a. Maximize Z = 20X1 + 6X2 + 8X3

s.t. 8X1 + 2X2 + 3X3 < 800

 4X1 + 3X2 < 480

 2X1 + X3 < 320

 X3 < 80

 X1 , X2 , X3 > 0

b. Excel solution

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **X1** | **X2** | **X3** | **Total** |  |  |
| Decision | 45 | 100 | 80 |  |  |  |
| Profit | $20 | $6 | $8 | $2,140 |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  | **Resources** |
|  | **X1** | **X2** | **X3** | **Used** |  | **Capacity** |
| Milling | 8 | 2 | 3 | 800 | <= | 800 |
| Lathes | 4 | 3 |  | 480 | <= | 480 |
| Grinders | 2 |  | 1 | 170 | <= | 320 |
| Sales |  |  | 1 | 80 | <= | 80 |
|  |  |  |  |  |  |  |

1. Solution is X1 = 45 S1 = 0 Z = $2140

X2 = 100 S2 = 0

X3 = 80 S3 = 150

 S4 = 0

1. S1 = 0 implies milling machines at capacity

 S2 = 0 implies lathes at capacity

 S3 = 150 implies grinders not at capacity, with 150 hours available

 S4 = 0 implies that X3 is at maximum sales capacity

1. The shadow price for the milling machine department is $2.25 per hour. Since it only cost $1.50 per hour to work overtime in this department, it is worthwhile to do so. The allowable increase in overtime is 400; however, only 200 hours are available. Therefore, it is recommended that 200 hours of overtime in the milling machine department be used.

4. a.

 Let A = pounds of food A

 B = pounds of food B

 Minimize : z = .75A + .15B

 s.t. 600A + 900B < 3,600 Maximum calories

 600A + 900B > 1,800 Minimum calories

 200A + 700B < 1,400 Maximum starch

 400A + 100B > 400 Minimum protein

 A < 2 Maximum amount of A



5. Add constraint 100B < 150, and change objective function to z = 1.75A + 2.50B



6. a.

 Let A = gallons of fuel A to mix

 B = gallons of fuel B to mix

 Minimize z = 1.20A + 0.90B

 s.t. A + B > 3,000 fuel demand

 A + B < 4,000 Maximum storage

 A < 2,000 Maximum fuel A available

 B < 4,000 Maximum fuel B available

 10A - 5B > 0 Blend 80 octane minimum\*

 A, B > 0 \*Note, blend constraint can be stated as (90A + 75B)/(A + B) > 80

b.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **A** | **B** | **Total** |  |  |
| Decision | 1000 | 2000 | 3000 |  |  |
| Cost | $1.20 | $.90 | $3,000 |  |  |
|  |  |  |  |  |  |
|  |  |  | **Resources** |
|  | **A** | **B** | **Used** |  | **Capacity** |
| Min demand | 1 | 1 | 3000 | >= | 3000 |
| Max Storage | 1 | 1 | 3000 | <= | 4000 |
| Max Fuel A | 1 |  | 1000 | <= | 2000 |
| Max Fuel B |  | 1 | 2000 | <= | 4000 |
| Blend | 10 | -5 | 0 | > | 0 |
|  |  |  |  |  |  |

Graphical solution--the problem requested the Excel solution, but the following graphical solution is provided for classroom use if desired.



7. Let: F = dollars spent on food

S = dollars spent on shelter

E = dollars spent on entertainment

Maximize Z = 2F + 3S + 5E

s.t. F + S + E < 1500 Total Budget

 F + S < 1000 Maximum on Food and Shelter

 S < 700 Maximum on Shelter alone

 E < 300 Maximum on Entertainment

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   | **F** | **S** | **E** | **Total** |  |  |
| Decision | 300 | 700 | 300 |  |  |  |
| Profit | 2 | 3 | 5 | 4,200 |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  | **Resources** |
|  | **X1** | **X2** | **X3** | **Used** |  | **Capacity** |
| total budget | 1 | 1 | 1 | 1300 | <= | 1500 |
| $ on food and shelter | 1 | 1 |  | 1000 | <= | 1000 |
| $ on shelter |  | 1 |  | 700 | <= | 700 |
| $ on entertainment |  |  | 1 | 300 | <= | 300 |
|  |  |  |  |  |  |  |

8. Produce 50 barrels of Expansion Draft and 50 barrels of Burning River. The total revenue will be $1400.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Expansion Draft** | **Burning River** | **Total** |  |  |
| Decision | 50 | 50 |  |  |  |
| Sales | $20 | $8 | $1400 |  |  |
|  |  |  |  |  |  |
|  |  |  | **Resources** |
|  | **X1** | **X2** | **Used** |  | **Capacity** |
| Corn | 8 | 2 | 500 | <= | 500 |
| Rice | 0 | 6 | 300 | <= | 300 |
| Hops | 4 | 3 | 350 | <= | 400 |
|  |  |  |  |  |  |

9. Run zone for 6 hours and man for 4 hours at a cost of $384.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Zone** | **Man** | **Total** |  |  |
|  |  |  |  |  |  |
| Decision | 6 | 4 |  |  |  |
| Cost | $48  | $24  | $384 |  |  |
|  |  |  |  |  |  |
|  |  |  | **Processes** |
|  | **X1** | **X2** | **Produced** |  | **Demand** |
| BCP1 | 3 | 1 | 22 | >= | 20 |
| BCP2 | 1 | 1 | 10 | >= | 10 |
| BCP3 | 1 | 0 | 6 | >= | 6 |
|  |  |  |  |  |  |

10. She should plant 700 acres in corn and 100 acres in soybeans.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Corn** | **Soybeans** | **Wheat** | **Total** |  |  |
| Decision | 700 | 100 | 0 | 800 |  |  |
| Profit per acre | $2,000  | $2,500  | $3,000  | $1,650,000 |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  | **Resources** |
|  | **Corn** | **Soybeans** | **Wheat** | **Used** |  | **Capacity** |
| Labor (workers) | 0.1 | 0.3 | 0.2 | 100 | <= | 100 |
| Fertilizer (tons) | 0.2 | 0.1 | 0.4 | 150 | <= | 150 |
| Acres Planted | 1 | 1 | 1 | 800 | <= | 900 |
|  |  |  |  |  |  |  |