COMM 290 Review

COMMERCE MENTORSHIP PROGRAM

OCTOBER 15, 2013

Midterm

- Covering only topics likely to be relevant
- Primarily algebra related to feasible region, optimal solution, allowable increase/decrease
- Reading Excel models and sensitivity reports
- Took the midterm summer of 2013, identical to midterms for previous years and practice midterm

Agenda

- Brief review of key terms and concepts
- Majority of time spent on practice questions resembling midterm
- Feel free to jump in anytime if you have a question regarding material covered
- If time left – any further questions you may have beyond material covered

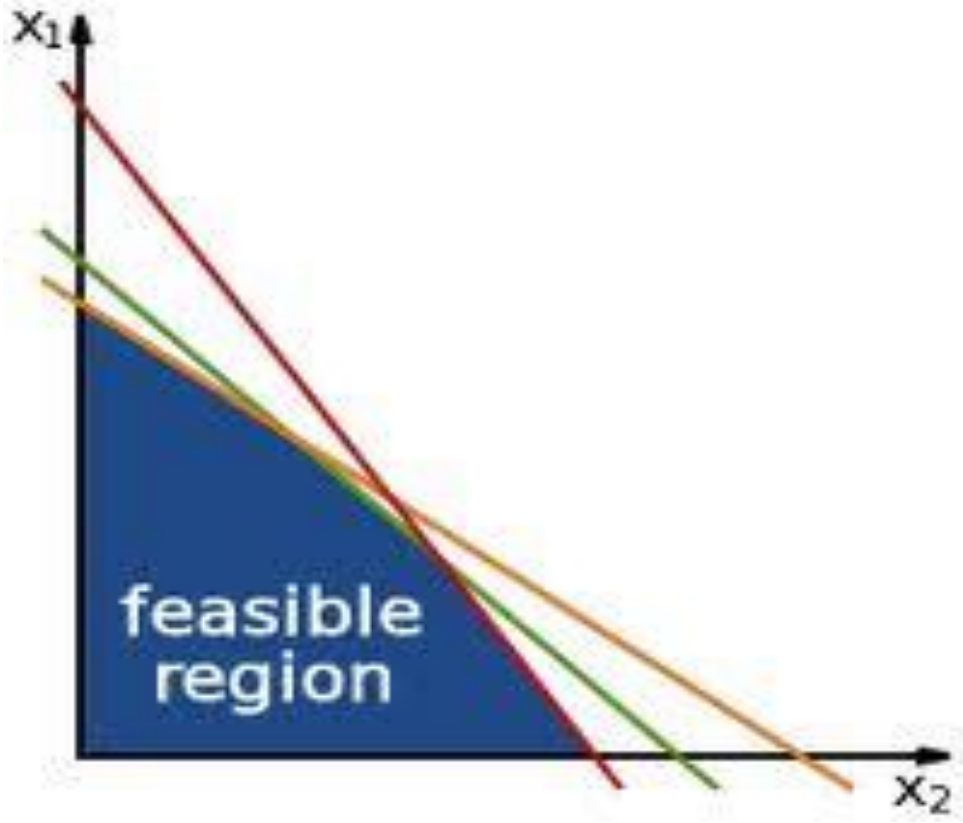
Constraints

- Limits on production
- Given in text format
- Identify the constraints:
- Be comfortable with graphing

Telco produces both a cell phone and a standard phone for the national market. Both phones pass through assembly, electronics and testing which have respectively 320 hours, 720 hours and 200 hours available each week. Cell phones require 1 hour in assembly, 4 hours in electronics and ½ hour in testing. Standard phones require 2 hours, 1 hour and 1 hour respectively in assembly, electronics and testing. Due to contractual obligations, at least 30 standard phones must be produced each week but, due to limited storage space available, no more than 140 standard phones can be produced each week. Profit contributions are $10 for the cell phone and $12 for the standard phone.

Feasible Region

- Combinations of production that satisfy all constraints
  - Be careful of minimum vs. maximum constraints
- Optimal solution will lie on an edge
  - Interior points underutilize resources
  - Move onto higher isoprofit curve



Word Problem 1

Sauder Global manufactures 2 products, the Sword (X) and the Pen (Y) – Max profit

- Assembly of each X requires 20 minutes of labour and each Y requires 30 minutes of labour. There are 190 hours of labour available in the next week.
- Each X requires 2 units of steel and each Y requires 1 unit of steel. 540 units of steel are available for the next week.
- Minimum production requirement of 30 X and 50 Y
- Maximum production limit of 200 X
- Profit contribution is $5 for each X and $4 for each Y

Word Problem 1.1

- Graph and label all constraints
- Identify the feasible region
- Identify the optimal solution
- Why is the point (50,100) not optimal?
- What is the shadow price of the Metal constraint?

•Assembly of each X requires 20 minutes of labour and each Y requires 30 minutes of labour. There are 190 hours of labour available in the next week.
•Each X requires 2 units of steel and each Y requires 1 unit of steel. 540 units of steel are available for the next week.
•Minimum production requirement of 30 X and 50 Y
•Maximum production limit of 200 X
•Profit contribution is $5 for each X and $4 for each Y

Word Problem 2

Sauder Global grows 2 crops, Radishes (X) and Onions (Y) – Max revenue

- Planting each acre of X takes 1 hour and Y takes 2 hours – 615 hours available
- Harvesting each acre of X takes 2 hours and Y takes 1.5 hours – 900 hours available
- Minimum production requirement of 80 X
- Revenue contribution is $200 for each X and $300 for each Y
- 680 acres available

Word Problem 2.1

- Identify all constraints
- What recommendation would you provide?
- Should you procure more land to grow crops?
- What is the shadow price of Harvest time?
- One extra hour of Planting time is worth $120 and this is valid up to 1066.67 Planting hours. Should you add 100 hours of planting time or 300 extra hours of harvest time?

Sauder Global grows 2 crops, Radishes (X) and Onions (Y) – Max revenue

•Planting each acre of X takes 1 hour and Y takes 2 hours – 615 hours available
•Harvesting each acre of X takes 2 hours and Y takes 1.5 hours – 900 hours available
•Minimum production requirement of 80 X
•Revenue contribution is $200 for each X and $300 for each Y
•680 acres available

Word Problem 2.2

- What is the allowable increase/decrease for Harvest?
- Over what range of revenue for X will the optimal solution remain the same?
- You are now able to rent out each acre of land at $175, what is the best solution?

Sauder Global grows 2 crops, Radishes (X) and Onions (Y) – Max revenue

•Planting each acre of X takes 1 hour and Y takes 2 hours – 615 hours available
•Harvesting each acre of X takes 2 hours and Y takes 1.5 hours – 900 hours available
•Minimum production requirement of 80 X
•Revenue contribution is $200 for each X and $300 for each Y
•680 acres available

Excel Models

- Constants (in Yellow)
- Decision Variables (in Red)
- Constraints (in Blue)
- Target (in Green)

- How many Liftmasters?
- What is the objective?

Frandec Company

Inputs

	Frame	Support	Strap	Time Used		Time Available		Time Available	
Cutting	3.5	1.3	0.4	20880	<=	20880	minutes	348	hours
Milling	2.2	1.7	0	21952	<=	25200	minutes	420	hours
Shaping	3.1	2.6	1.7	32983	<=	40800	minutes	680	hours
Per Liftmaster	1	2	1						

Cost

Manufacturing	$ 36.00	$ 11.50	$ 6.50
Purchase	$ 45.00	$ 15.00	$ 7.50

Action Plan

	Frame	Support	Strap
Make	2251	10000	3
Buy	2749	0	4997
Supply	5000	10000	5000
	>=	>=	>=
	5000	10000	5000

Cost Issues

	Frame	Support	Strap	Total
Make	$ 81,036.00	$115,000.00	$19.50	$ 196,055.50
Buy	$123,705.00	$ -	$37,477.50	$ 161,182.50
Total	$204,741.00	$115,000.00	$37,497.00	$ 357,238.00

Sensitivity Report 1

- Reduced Cost is the amount that the Objective Coefficient must change by for the resource to be part of the optimal solution
- The Objective Coefficient is the amount that the decision variable contributes to the Target
- Allowable Increase/Decrease for Decision variables indicates the range in which the Objective Coefficient can move and not change the optimal solution

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
E16	Make Frame	5000	0	36	5.576923077	45.42307692
F16	Make Support	2600	0	11.5	0.250000001	2.071428571
G16	Make Strap	0	0.076923077	6.5	1E+30	0.076923077
E17	Buy Frame	0	5.576923077	51	1E+30	5.576923077
F17	Buy Support	7400	0	15	2.071428571	0.250000001
G17	Buy Strap	5000	0	7.5	0.076923077	7.5

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
E18	Supply Frame	5000	45.42307692	5000	965.7142857	2748.571429
F18	Supply Support	10000	15	10000	1E+30	7400
G18	Supply Strap	5000	7.5	5000	1E+30	5000
H6	Cutting Time Used	20880	-2.692307692	20880	7478.823529	3380
H7	Milling Time Used	15420	0	25200	1E+30	9780
H8	Shaping Time Used	22260	0	40800	1E+30	18540

Sensitivity Report 1.1

- Shadow Price is the effect on the Target for each additional unit of the constraint
  - Zero for non-binding constraints
- Allowable Increase/Decrease for Constraints indicates the range in which the Constraint can move without changing the Shadow Price
  - Infinity for non-binding constraints

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
E16	Make Frame	5000	0	36	5.576923077	45.42307692
F16	Make Support	2600	0	11.5	0.250000001	2.071428571
G16	Make Strap	0	0.076923077	6.5	1E+30	0.076923077
E17	Buy Frame	0	5.576923077	51	1E+30	5.576923077
F17	Buy Support	7400	0	15	2.071428571	0.250000001
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Constraints

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H7	Milling Time Used	15420	0	25200	1E+30	9780
H8	Shaping Time Used	22260	0	40800	1E+30	18540

Excel Problem 1

- How many Liftmasters should be assembled?
- How many Frames are manufactured?
- What is the total manufacturing cost for Liftmasters?
- How many Liftmasters can be assembled using only parts that were purchased?
- Which department(s) are limiting manufacturing?

Question 3

Frandec

Input Data

	Prod Time (minutes)per unit			Time Used		Time Available		Time Available	
	Frame	Support	Strap						
Cutting	3.6	1.75	0.9	16961.5385	<=	18000	*minutes*	300	*hours*
Milling	2.6	1.9	0	9000	<=	9000	*minutes*	150	*hours*
shaping	3.2	2.8	1.5	18576.9231	<=	21000	*minutes*	350	*hours*

	Frame	Support	Strap
Manufac.Cost	$40.00	$12.00	$7.00
Purchasing Cost	$53.00	$16.00	$9.00

Action Plan

	Frame	Support	Strap	
Make	3,462	0	5,000	Units
Buy	1,538	15,000	0	Units
Supply	5,000	15,000	5,000	Units
	>=	>=	>=	
Demand	5,000	15,000	5,000	

Cost Issues

	Frame	Support	Strap	Total
Make	138,461.54	0.00	35,000.00	173,461.54
Buy	81,538.46	240,000.00	0.00	321,538.46
Total	220,000.00	240,000.00	35,000.00	495,000.00

Sensitivity Report

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C18	Make Frame	3,462	0	40	7.52632	1E+30
D18	Make Support	0	5	12	1E+30	5.5
E18	Make Strap	5,000	0	7	2	7
C19	Buy Frame	1,538	0	53	1E+30	7.52631579
D19	Buy Support	15,000	0	16	5.5	16
E19	Buy Strap	0	2	9	1E+30	2

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
F7	Cutting Used	16961.538	0	18000	1E+30	1038.46154
F8	Milling Used	9000	-5	9000	750	9000
F9	shaping Used	18576.923	0	21000	1E+30	2423.07692
C20	Supply Frame	5,000	53	5000	1E+30	1538.46154
D20	Supply Support	15,000	16	15000	1E+30	15000
E20	Supply Strap	5,000	7	5000	1153.85	5000

Excel Problem 1.1

- Of all Straps, how many will be attached to frames that were manufactured?
- Suppose the cost of manufacturing Frames increased by $4, should you buy more frames?
- When should you manufacture Supports?

Question 3

Frandec

Input Data

	Prod Time (minutes)per unit			Time Used		Time Available		Time Available	
	Frame	Support	Strap						
Cutting	3.6	1.75	0.9	16961.5385	<=	18000	*minutes*	300	*hours*
Milling	2.6	1.9	0	9000	<=	9000	*minutes*	150	*hours*
shaping	3.2	2.8	1.5	18576.9231	<=	21000	*minutes*	350	*hours*

	Frame	Support	Strap
Manufac.Cost	$40.00	$12.00	$7.00
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Action Plan

	Frame	Support	Strap	
Make	3,462	0	5,000	Units
Buy	1,538	15,000	0	Units
Supply	5,000	15,000	5,000	Units
	>=	>=	>=	
Demand	5,000	15,000	5,000	

Cost Issues

	Frame	Support	Strap	Total
Make	138,461.54	0.00	35,000.00	173,461.54
Buy	81,538.46	240,000.00	0.00	321,538.46
Total	220,000.00	240,000.00	35,000.00	495,000.00

Sensitivity Report

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C18	Make Frame	3,462	0	40	7.52632	1E+30
D18	Make Support	0	5	12	1E+30	5.5
E18	Make Strap	5,000	0	7	2	7
C19	Buy Frame	1,538	0	53	1E+30	7.52631579
D19	Buy Support	15,000	0	16	5.5	16
E19	Buy Strap	0	2	9	1E+30	2

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
F7	Cutting Used	16961.538	0	18000	1E+30	1038.46154
F8	Milling Used	9000	-5	9000	750	9000
F9	shaping Used	18576.923	0	21000	1E+30	2423.07692
C20	Supply Frame	5,000	53	5000	1E+30	1538.46154
D20	Supply Support	15,000	16	15000	1E+30	15000
E20	Supply Strap	5,000	7	5000	1153.85	5000

Excel Problem 1.2

- If Milling time was reduced by 10 hours, will the optimal solution change?
- If an additional 5 hours of Milling Time could be obtained at regular cost:
  - What is the effect on the Target?
  - Will the Optimal solution change?
- Would you obtain an additional 20 hours of Milling time for $1,000?

Question 3

Frandec

Input Data

	Prod Time (minutes)per unit			Time Used		Time Available		Time Available	
	Frame	Support	Strap						
Cutting	3.6	1.75	0.9	16961.5385	<=	18000	*minutes*	300	*hours*
Milling	2.6	1.9	0	9000	<=	9000	*minutes*	150	*hours*
shaping	3.2	2.8	1.5	18576.9231	<=	21000	*minutes*	350	*hours*

	Frame	Support	Strap
Manufac.Cost	$40.00	$12.00	$7.00
Purchasing Cost	$53.00	$16.00	$9.00

Action Plan

	Frame	Support	Strap	
Make	3,462	0	5,000	Units
Buy	1,538	15,000	0	Units
Supply	5,000	15,000	5,000	Units
	>=	>=	>=	
Demand	5,000	15,000	5,000	

Cost Issues

	Frame	Support	Strap	Total
Make	138,461.54	0.00	35,000.00	173,461.54
Buy	81,538.46	240,000.00	0.00	321,538.46
Total	220,000.00	240,000.00	35,000.00	495,000.00

Sensitivity Report

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C18	Make Frame	3,462	0	40	7.52632	1E+30
D18	Make Support	0	5	12	1E+30	5.5
E18	Make Strap	5,000	0	7	2	7
C19	Buy Frame	1,538	0	53	1E+30	7.52631579
D19	Buy Support	15,000	0	16	5.5	16
E19	Buy Strap	0	2	9	1E+30	2

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
F7	Cutting Used	16961.538	0	18000	1E+30	1038.46154
F8	Milling Used	9000	-5	9000	750	9000
F9	shaping Used	18576.923	0	21000	1E+30	2423.07692
C20	Supply Frame	5,000	53	5000	1E+30	1538.46154
D20	Supply Support	15,000	16	15000	1E+30	15000
E20	Supply Strap	5,000	7	5000	1153.85	5000

Excel Problem 1.3

- What is the best formula for cell F7?
- What is the formula for H7?
- Cell D22 was entered as a number, a better choice would be to enter it as a formula. What is that formula?
- Liftmasters must now have Frames, Supports and Straps painted which requires 2, 1, and 0.8 minutes respectively. Total of 500 painting hours available. Setup the constraint and determine if it affects the optimal solution.

Question 3

Frandec

Input Data

	Prod Time (minutes)per unit			Time		Time		Time	
	Frame	Support	Strap	Used		Available		Available	
Cutting	3.6	1.75	0.9	16961.5385	<=	18000	*minutes*	300	*hours*
Milling	2.6	1.9	0	9000	<=	9000	*minutes*	150	*hours*
shaping	3.2	2.8	1.5	18576.9231	<=	21000	*minutes*	350	*hours*

	Frame	Support	Strap
Manufac.Cost	$40.00	$12.00	$7.00
Purchasing Cost	$53.00	$16.00	$9.00

Action Plan

	Frame	Support	Strap	
Make	3,462	0	5,000	Units
Buy	1,538	15,000	0	Units
Supply	5,000	15,000	5,000	Units
	>=	>=	>=	
Demand	5,000	15,000	5,000	

Cost Issues

	Frame	Support	Strap	Total
Make	138,461.54	0.00	35,000.00	173,461.54
Buy	81,538.46	240,000.00	0.00	321,538.46
Total	220,000.00	240,000.00	35,000.00	495,000.00

Sensitivity Report

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C18	Make Frame	3,462	0	40	7.52632	1E+30
D18	Make Support	0	5	12	1E+30	5.5
E18	Make Strap	5,000	0	7	2	7
C19	Buy Frame	1,538	0	53	1E+30	7.52631579
D19	Buy Support	15,000	0	16	5.5	16
E19	Buy Strap	0	2	9	1E+30	2

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
F7	Cutting Used	16961.538	0	18000	1E+30	1038.46154
F8	Milling Used	9000	-5	9000	750	9000
F9	shaping Used	18576.923	0	21000	1E+30	2423.07692
C20	Supply Frame	5,000	53	5000	1E+30	1538.46154
D20	Supply Support	15,000	16	15000	1E+30	15000
E20	Supply Strap	5,000	7	5000	1153.85	5000

Comm 290

Question 1

Maggie's Farms, with 680 acres of land available this season for crops, is located in Nova Scotia. For the upcoming growing season, Maggie's Farms is planning to grow two crops, Apples and Peaches. To meet earlier commitments, Maggie's Farms must be willing to plant a minimum of 80 acres of Apples. It takes one hour to plant each acre of Apples and 2 hours to plant each acre of Peaches. Harvesting times for Apples and Peaches are 2 hours per acre fro Apples and 1.5 hour for Peaches. Maggie's Farms estimates that it has 615 hours available for planting and 900 hours for harvest. Each acre of Peaches is expected to bring $200 in revenue where as each acre of Apples is expected to bring $300 in revenue.

Maggie's Farms is interested in maximizing revenue over the next growing season. T accomplish this, they hired a consulting firm to help solve this problem. The consulting firm has provided the correct linear programming model below in algebraic form.

a) Draw the graph and label all the constraints.
b) Identify the feasible region.
c) With respect to the primary decisions facing Maggie's Farms, if you were a consultant, what recommendation would you provide to Ms. Maggie?
d) How much revenue will Maggie's Farm realize if they operate at optimal solution?
e) If Maggie's Farms wanted to increase the amount indicated in part (d), should they increase planting or harvesting time?

Over what range for the unit profit on Beans would the optimal solution remain unchanged.

f) How much would revenue increase if Maggie could increase her harvest time by 1 extra hour?
g) Determine the allowable increase or allowable decrease for the harvest constraint.
h) What is the allowable increase for the acres constraint?
i) In an effort to increase revenue, should Maggie try and get more land on which to grow crops. Please comment.
j) Maggie knows from the consultant's report that one extra hour of Planting time is worth $120 and this is valid upto 1066.67 Planting hours. If Maggie could add 100 extra hours of planting time OR 300 extra hours of harvest time, which option should he choose? Provide evidence.

Problem 2

Maggie has noted from consultant's report that he has large parts of his farm that are not being used to plant and harvest Apples and Peaches. Maggie knows that,

because good farming land is in high demand, he could rent any amount of land to other farmers in the surrounding area for $175/acre.

a) According to the optimal solution, how many acres should b left unplanted?
b) Suppose, Maggie rents out 100 acres of his land so that the maximum available land for planting is now only 580 acres.
   (i) Would the feasible region change?
   (ii) Would the optimal solution change?
   (iii) Would the set of binding constraints change?

c) Maggie's boyfriend observed that if other farmers are willing to pay $175 per acre, Maggie would be financially better off growing no crops of their own and instead renting out all their land. Is he correct? Give reasons
d) Is there a solution better than both the consultant's and wife's solution? If yes, what's the revenue from the solution?

Questions 3 and 4

Input Data

	Design	Base	Belt	Time Used		Time Available		Time Available	
Drilling	3.33	1.3	0.8	15000	<=	15000	minutes	250	hours
Grazing	2.5	1.7	0	7830	<=	7830	minutes	130.5	hours
Polishing	3.1	2.6	1.7	19399	<=	24000	minutes	400	hours

	Design	Base	Belt
Manufacturing Cost	$ 38.00	$ 11.50	$ 6.50
Purchase Cost	$ 51.00	$ 15.00	$ 7.50

Action Plan

	Design	Base	Belt	
Make	3132		5700	units
Buy	3868	14000	1300	units
Supply	7000	14000	7000	units
	>=	>=	>=	
Demand	7000	14000	7000	units

Cost Issues

	Design	Base	Belt	Total
Make	$119,016.00		$37,050.00	$156,066.00
Buy	$197,268.00	$210,000.00	$ 9,750.00	$417,018.00
Total	$316,284.00	$210,000.00	$46,800.00	$573,084.00

Sensitivity Report

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C18	Make Design	3132	0	38	6.076	1.00E+30
D18	Make Base	0	4.132	11.5	1.00E+30	4.132
E18	Make Belt	5700	0	6.5	1	2.12
C19	Buy Design	3868	0	51	1.00E+30	6.076
D19	Buy Base	14000	0	15	4.132	15
E19	Buy Belt	1300	0	7.5	2.12	1

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H Side	Allowable Increase	Allowable Decrease
F7	Drilling Used	15000	-1.25	15000	1040	4560
F8	Grazing Usec	7830	-3.53	7830	3420	780
F9	Polishing Use	19399	0	24000	1.00E+30	4600.8
C20	Supply Desig	7000	51	7000	1.00E+30	3868
D20	Supply Base	14000	15	14000	1.00E+30	14000
E20	Supply Belt	7000	7.5	7000	1.00E+30	1300

Problem 3

Cayman Company manufactures and assembles material handling equipment used in warehouses and distribution. One product called the Liftbuster, is assembled from four components : a design, a motor, two bases and a belt. Cayman purchases the motors from an outside supplier, but Cayman can either manufacture the designs, bases and belts or purchase from an outside supplier.

Components	Manufacturing Cost	Purchase Cost
Design	$38	$51
Base	$11.50	$15
Belt	$6.50	$7.5

Three Departments are involved in the manufacture of these components. The time (in minutes per unit) required to make each component in reach department and the available capacity (in hours) for 3 department are as follows.

Department	Production Time (in min)	Production Time (in min)	Production Time (in min)	Time available (in hours)
	Design	Base	Belt	
Drilling	3 1/3	1.3	0.8	250
Grazing	2.2	1.7	0	130.5
Polishing	3.1	2.6	1.7	400

This problem was correctly formulated as a linear programming problem in Excel and solved using Solver The Solved model was with an optimal solution and an optimal solution and sensitivity report are attached. Use the printouts to answer the questions on the following pages.

a) How many liftbusters could be assembled next month?
b) How many designs are manufactured next month?
c) What is the total manufacturing cost for the liftbusters?
d) How many liftbusters can be assembled using only parts that were purchased?
e) Which manufacturing department(s) are limiting the manufacturing volume?
f) Of all the straps manufactured, how many will be attached to the designs that are manufactured?
g) How many variables and constraints are there in this problem?
h) Suppose the manufacturing cost for designs increased by $4.00. Would this change encourage Cayman to buy more frames?
i) Is there any evidence of multiple optima in this problem?
j) Suppose Cayman could get an additional 5 hours of Grazing time at the regular cost. What can you say about the effect this change will have one- 1. Target Cell and 2. Optimal Solution.

k) Suppose the cost of the extra Grazing Time in the question directly above cost $2.00 above the regular cost. What specific effect would this have on the value of the target cell?
l) If the amount of Drilling time and Grazing time were each reduced by 10 hours, would the optimal solution change?
m) Suppose Cayman can obtain 1200 extra minutes of Drilling Time for $1000. Should they do this? Provide evidence.
n) A labor dispute is expected to reduce the number of hours in Drilling by 800 hours. What can you say about the value of the shadow price for grazing below the allowable decrease? Does this make economic sense?

Problem 4

Refer to the previous "Cayman" problem to answer these additional questions

a) What is the best excel formula in cell F7?
b) What is the excel formula in H7?
c) In cell D22, the 14,000 was entered as a number. A better choice would have been if it had been entered as a formula. What should this formula be?
d) Is this cost of the motors a relevant or sunk cost in this problem?
e) Management has noticed that at optimal solution, all the available Drilling and Grazing time has been used. Does this mean that to improve their costs they would need to acquire more time in both of these departments?
f) Write all the algebraic supply/demand constraints for this problem. State your abbreviations.
g) Cayman has just been notified that its liftbuster customers require that all designs, bases and belts must be Polished before they are assembled. It takes 1.2 minutes to polish one design, 1.4 minutes to polish one base and 0.8 minutes to polish one belt. Cayman has 500 hours available for this task. Set up the algebraic constraint for painting?