

Lab. Session NO. 14-II

DATE: Dec.. 17, '13

Subj.: Linear Programming (LP) of Engineering Design Problems & The Simplex Method

Objectives:

To formulate (set-up) an LP-problem and to use the Excel-package and solve for optimal values of an objective function and the design variables

A Company produces *two* products A and B and the *goal* (objective), is to **maximize the profits**. The *restrictions* (*constraints*) of the company are:

- Total time allowed: 40 hours/week.
- Raw material required: for **A** 20 kg; for **B** 5 kg.
- Total raw material available per week 10 000 kg.
- Times allowed: for **A** 0.05; for **B** 0.15.
- Storage space: 550 kg/week.
- Unit profits: for **A** SR. 240; for **B** SR. 300.

The problem is to be formulated in a Linear Programming format (*i.e.* LP *problem*) in terms of objective function $Z(x)$ and design constraints $g(x)$.

(a) *Set up* the LP problem to maximize profit function:

$$Z(x) = 240 x_1 + 300 x_2$$

- (b) Solve the problem using EXCEL Microsoft-program.
(c) Print-out and study the results and record your conclusions.

Note: The attached sheets will guide you to set-up and solve the LP -problem using EXCEL Microsoft spreadsheet.

Supporting Notes: Using Excel for solving an LP Problem

- **EXCEL for Linear Programming:**

There are a variety of software packages expressly designed to implement linear programming. However, because of its broad availability, we will focus on the Excel spreadsheet. This involves using the Solver option previously employed in Chap. 7 for root location.

The manner in which Solver is used for linear programming is similar to our previous applications in that the data is entered into spreadsheet cells. The basic strategy is to arrive at a single cell that is to be optimized as a function of variations of other cells on the spreadsheet. The following example illustrates how this can be done for the gas-processing problem.

Using Excel's Solver for a Linear Programming Problem

Problem Statement. Use Excel to solve the gas-processing problem we have been examining in this chapter.

Solution. An Excel worksheet set up to calculate the pertinent values in the gas-processing problem is shown in Fig. 15.5. The unshaded cells are those containing numeric and labeling data. The shaded cells involve quantities that are calculated based

FIGURE 15.5

Excel spreadsheet set up to use the Solver for linear programming.

	A	B	C	D	E
1	Gas Processing Problem				
2					
3		Regular	Premium	Total	Available
4	Produced	0	0		
5					
6	Raw	7	11	0	77
7	Time	10	8	0	80
8	Storage Regular			0	9
9	Storage Premium			0	0
10					
11	Unit profit	150	175		
12	Profit	0	0	0	

$= B6*B4+C6*C4$
 $= B7*B4+C7*C4$
 $= B4$
 $= C4$
 $= B4*B11$ $= C4*C11$ $= B12+C12$

on other cells. Recognize that the cell to be maximized is D12, which contains the total profit. The cells to be varied are B4:C4, which hold the amounts of regular and premium gas produced.

Once the spreadsheet is created, Solver is chosen from the Tools menu. At this point a dialogue box will be displayed, querying you for pertinent information. The pertinent cells of the Solver dialogue box are filled out as

Set target cell:	D12
Equal to	<input checked="" type="radio"/> max <input type="radio"/> min <input type="radio"/> equal to
By changing cells:	B4:C4
Subject to:	D6<=E6 D7<=E7 D8<=E8 D9<=E9

The constraints must be added one by one by selecting the “Add” button. This will open up a dialogue box that looks like

Cell reference:	Constraint
D6	<= E6

As shown, the constraint that the total raw gas (cell D6) must be less than or equal to the available supply (E6) can be added as shown. After adding each constraint, the “Add” button can be selected. When all four constraints have been entered, the OK button is selected to return to the Solver dialogue box.

Now, before execution, the Solver options button should be selected and the box labeled “Assume linear model” should be checked off. This will make Excel employ a version of the simplex algorithm (rather than the more general nonlinear solver it usually uses) that will speed up your application.

After selecting this option, return to the Solver menu. When the OK button is selected, a dialogue box will open with a report on the success of the operation. For the present case, the Solver obtains the correct solution (Fig. 15.6)

FIGURE 15.6

Excel spreadsheet showing solution to linear programming problem.

	A	B	C	D	E
1	Gas Processing Problem				
2					
3		Regular	Premium	Total	Available
4	Produced	4.888889	3.888889		
5					
6	Raw	7	11	77	77
7	Time	10	8	80	80
8	Storage Regular			4.888889	9
9	Storage Premium			3.888889	6
10					
11	Unit profit	150	175		
12	Profit	733.3333	680.5556	1413.889	