Bonus Assignment 3:
Based on the problems described below, formulate the problems as nonlinear programs and attempt to solve using Microsoft Excel. Completely describe your decision variables, objective, and constraints. You may complete this work as a small group.

Maximum bonus points: 50 (25 per question)

Question 1:
A large food chain owns a number of pharmacies that operate in a variety of settings. Some are situated in small towns and are open for only 8 hours a day, 5 days per week. Others are located in shopping malls and are open for longer hours. The analysts on the corporate staff would like to develop a model to show how a store's revenues depend on the number of hours that it is open. They have collected the following information from a sample of stores.

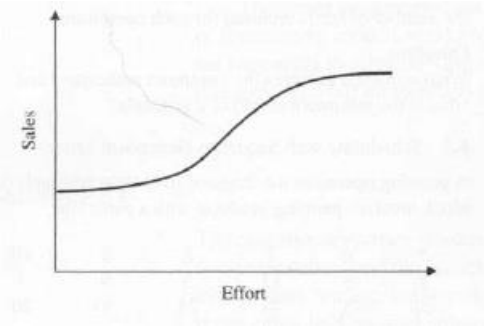
Hours of Operation	Average Revenue ($)
40	5958
44	6662
48	6004
48	6011
60	7250
70	8632
72	6964
90	11097
100	9107
168	11498

a) Use a linear function to represent the relationship between revenue and operating hours and find the values of the parameters using the LSGRG solver that provide the **best fit** to the given data. What revenue does your model predict for 120 hours?

b) Suggest a two-parameter nonlinear model for the same relationship and find the parameters using the Nonlinear Solver that provide the **best fit**. What revenue does your model predict for 120 hours? Which if the models in (a) and (b) do you prefer and why?

Your solutions for (a) and (b) should contain a detailed spreadsheet model (where the decision variables, parameters, objective function and constraints are identified and explained), as well as answers to the questions posed. You should use Microsoft Excel solve.

Question 2:
An organization has increased its profitability dramatically by using models to allocate its sales force among the company's major drugs. To guide that effort, a non-linear sales response curve is estimated for each drug. A sales-response curve relates the sale of a product to the effort expended to sell it, which in this case is measured by the number of calls made by the sales force. The following figure shows the typical shape of such a curve:



For low levels of effort, sales rise rapidly with increased effort, but eventually the sales response levels out. Two elements are needed to develop a sales-response curve for a particular product: (1) some data or managerial judgments on the sales at various levels of effort and (2) a family of S-shaped curves to fit the data. A suitable family of curves for the organization is given by the function:

$$S = a + \frac{(b-a)E^c}{(d + E^c)}$$

where *S* is sales, *E* is effort, and *a*, *b*, *c*, and *d* are parameters that determine the shape and location of the curve. At the organization, sales of a particular drug were around 200 cases with a sales effort of 500 calls. Management was then asked to estimate sales at other levels of effort. Their estimates are as follows:

Effort (%)	Actual Sales (% of Current)
0	50
25	53
50	55
75	75
100	100
125	120
150	127
175	132
200	135

Using the Evolutionary Solver Microsoft Excel, solve both questions (a) and (b) below. Your solution should contain a detailed spreadsheet model (where the decision variables, parameters, objective function and constraints are identified and explained), as well as answers to the questions posed.

(a) Fit a sales-response curve to the data above using a least-squares criterion. Use percentages relative to the base case for the effort and sales measures. What are the best values of the parameters *a, b, c,* and *d*?
(b) What sales does the model in part (a) predict for an effort of 115%?

Hint: You may need to run numerous trials with Evolutionary Solver (i.e., the solution of Trial 1 is the starting point for Trial 2)