

## Problem Set 1

For each of the following situations, create an Excel model and use Solver to find solutions.

### Problem 1 - Production Planning

Kentwood Electronics manufactures three components for stereo systems: CD players, tape decks, and stereo tuners. The wholesale price and manufacturing costs for each item are given below:

Wholesale Manufacturing		
Component	Price	Cost
CD Player	\$150	\$75
Tape Deck	\$85	\$35
Stereo Tuner	\$70	\$30

Each CD player requires three hours of assembly; each tape deck requires two hours of assembly; and each tuner requires one hour of assembly. The marketing department has indicated that it can sell no more than 150,000 CD players, 100,000 tape decks, and 90,000 stereo tuners. However, the demand is expected to be at least 50,000 units of each item, and Kentwood wants to meet this demand. Kentwood has 400,000 hours of assembly time available. What should Kentwood produce to maximize profits?

### Problem 2 - Product Mix

A real estate developer is planning to build an apartment complex for graduate students on a parcel of land adjacent to a major university. Four types of apartments can be included in the building: efficiencies, and one-, two-, or three-bedroom units. Each efficiency requires 50 square meters; each one-bedroom apartment requires 70 square meters; each two-bedroom apartment requires 80 square meters; and each three-bedroom unit requires 100 square meters.

The developer believes that the building should include no more than 15 one-bedroom units, 22 two-bedroom units, and 10 three-bedroom units. Local zoning ordinances do not allow the developer to build more than 45 units in this particular location, and restrict the building to a maximum of 4000 square meters. The developer has already agreed to lease 5 one-bedroom units and 8 two-bedroom units to a local rental agency that is a “silent partner” in this project. Market studies indicate that efficiencies can be rented for 3000 F per month, one-bedrooms for 4500 F per month, two-bedrooms for 5500 F per month, and three-bedrooms for 7500 F per month.

Develop a model to determine a plan that maximizes the potential rental income from the building.

### Problem 3 - Transportation and Logistics

A winery can produce an exclusive wine at either of its two vineyards: it can produce 3500 bottles at a cost of 23 F per bottle at Vineyard 1, and 3100 bottles for 25 F each at Vineyard 2.

Four fine restaurants around the country are interested in purchasing this wine. Because the wine is exclusive, they all want to buy as much as they need but will take whatever they can get. The maximum amounts required by the restaurants and the prices they are willing to pay are summarized below:

Restaurant	Maximum demand	Price
A	1,800 bottles	69 F
B	2,300 bottles	67 F
C	1,250 bottles	70 F
D	1,750 bottles	66 F

The costs of shipping a bottle from the vineyards to the restaurants are summarized below:

Vineyard	Restaurant			
	A	B	C	D
1	7 F	8 F	13 F	9 F
2	12 F	6 F	8 F	7 F

The winery needs to determine the production and shipping plan that allows it to maximize its profit.

### Problem 4 - Diversifying investments

Kathleen Allen, an individual investor, has \$70,000 to divide among several investments. The alternative investments are municipal bonds with an 8.5% annual return, certificates of deposit with a 5% return, treasury bills with a 6.5% return, and a growth stock fund with an expected annual return of 13%. The investments are all evaluated after one year. However, each investment alternative has a different perceived risk to the investor; thus, it is advisable to diversify. Kathleen wants to know how much to invest in each alternative in order to maximize the return.

The following guidelines have been established for diversifying the investments and lessening the risk perceived by the investor.

- No more than 20% of the total investment should be in municipal bonds.
- The amount invested in certificates of deposit should not exceed the amount invested in the other three alternatives.
- At least 30% of the investment should be in treasury bills and certificates of deposit.
- To be safe, more should be invested in CDs and treasury bills than in municipal bonds and the growth stock fund by a ratio of at least 1.2 to 1.

Kathleen wants to invest the entire \$70,000.

### Problem 5 - Scheduling

Maintenance at a major theme park in the Paris area is an on-going process that occurs 24 hours a day. Because it is a long commute from most residential areas to the park, employees do not like to

work shifts of fewer than eight hours. These 8-hour shifts start every four hours throughout the day. The number of maintenance workers needed at different times throughout the day varies. The following table summarizes the minimum number of employees needed in each 4-hour time period.

<b>Time Period</b>	<b>Minimum employees needed</b>
12am to 4am	90
4am to 8am	215
8am to 12pm	250
12pm to 4pm	165
4pm to 8pm	300
8pm to 12am	125

The maintenance supervisor wants to determine the minimum number of employees to schedule that meets the minimum staffing requirements. Create a spreadsheet model for this problem and solve it using Solver.

### **Problem 6 - Pairs Matching**

PROTRAC's European headquarters is in Brussels. As part of his annual audit, the president has decided to have each of the four corporate vice-presidents visit and audit one of the assembly plants located in Leipzig, Germany; Nancy, France; Liège, Belgium; and Tilburg, the Netherlands.

There are a number of advantages and disadvantages to various assignments of the vice-presidents to the plants. Among the issues to consider are:

- matching the vice-presidents' areas of expertise with specific problem areas in a plant;
- the time the audit will require and the other demands on each vice-president during this time;
- matching the language ability of a vice-president with the dominant language used in the plant.

Attempting to keep all these factors in mind, the president decides to start by estimating the cost to PROTRAC of sending each vice-president to each plant. Using the cost data shown in the following table, formulate an optimization model to determine the best assignment of vice-presidents to the various plants.

*Assignment costs for each vice-president/plant combination*

Vice-president	Plant			
	Leipzig	Nancy	Liège	Tilburg
Finance (F)	24	10	21	11
Marketing (M)	14	22	10	15
Operations (O)	15	17	20	19
Personnel (P)	11	19	14	13

### **Problem 7 - Human Resources Management**

Europ'Air (EA) must plan the hiring and training of new flight attendants over the next six months. EA will need 8000 hours of experienced flight attendant coverage in January, 9000 hours in

February, 8000 hours in March, 10000 in April, 9000 in May and 12000 hours in June.

It takes one month of training before a flight attendant can be put on a regular flight, so a new crew member must be hired at least one month before he or she is actually needed. Also, a trainee requires 100 hours of in-flight experience during the month of training. This 100 hour requires half-time supervision by a trained flight attendant, so it adds 50 hours per trainee to the amount of flight crew coverage needed in the training month.

Each experienced flight attendant can work up to 150 hours in a month, and Europ'Air has 60 experienced flight attendants available at the beginning of January. If the time available from experienced flight attendants exceeds a month's flying and training requirements, the experienced attendants work less than 150 hours but still receive a full month's pay. At the end of each month, about 10% of the experienced attendants quit. An experienced attendant earns 1200 € a month and a trainee 600 € a month.

Formulate a model to help decide the hiring and training plan.

### **Problem 8 - Dealing with decreasing returns in a linear model**

Revisit Problem 1 above (Kentwood Electronics). Suppose there are *decreasing returns*, such that the unit wholesale price of CD players is \$150 for up to 60,000 unit, but \$140 per unit thereafter. Modify the problem formulation, still keeping a linear optimization model, to account for this decreasing selling price.