

# Management Science

## Linear Programming: Practice Problems

**Question 1:** Galaxy Industries would like to determine production levels for four of its toy water guns that will maximize the total profit. Galaxy wants to produce at least 100 units and at most 1000 units of each toy water gun. The following table summarizes the profits and the resources requirements. The last row provides the resources available per week.

Product	Profit	Plastic(lbs.)	Production time (min)
Space Ray	€16	2	3
Zapper	€15	1	4
Big Squire	€20	3	5
Soaker	€22	4	6
	Available	3000	6000

1. Formulate an LP model for this problem?
2. Solve the problem using Gurobi.
3. What is the optimal solution?

**Question 2:** Your company makes a variety of products. A large order for three products has just been received from a customer who also requested a very short due date. A quick calculation revealed that the limiting resource is the labor time; only 200 labor hours are available, and that is not enough to make all the requested units of products. Some units must be outsourced to subcontractors. Two subcontractors are available. Subcontractor A has low prices, but can only

provide a maximum of 60 units of all products in total. Sub-contractor B is more expensive, but can provide any number of units of any product. Your company wants to decide how many units of each product to make and how many units to buy from each subcontractor in order to minimize the total cost. The table below summarizes all necessary information.

	<b>Product 1</b>	<b>Product 2</b>	<b>Product 3</b>
Cost of making a unit	€6	€13	€20
Cost of buying a unit from A	€12	€15	€21
Cost of buying a unit from B	€11	€16	€23
Labor hours/unit	1	2	3
Demand(units)	100	80	70

1. Formulate on paper an LP model for this problem?
2. Solve the problem using Gurobi.
3. What is the optimal solution?

**Question 3:** A trust officer at the Maltese National Bank needs to determine how to invest €100,000 in the following collection of bonds to maximize the annual return.

Bond	Annual return	Maturity	Risk	Tax-Free
A	9.5%	Long	High	Yes
B	8%	Short	Low	Yes
C	9%	Long	Low	No
D	9%	Long	High	Yes
E	9%	Short	High	No

The officer wants to invest at least 50% of the money in short-term issues and no more than 45% in high risk issues. At least 30% of the funds should go into tax-free investments and at least 40% of the total annual return should be tax-free.

1. Formulate on paper an LP model for this problem?
2. Solve the problem using Gurobi.
3. What is the optimal solution?

**Question 4:** *Laura's garden* is a leading grower and distributor of citrus products. It has three citrus groves at locations A, B and C. LG currently has 2750 tones of citruses at A, 4000 tones of citruses at B and 3000 tones of citruses at C. LG has citrus processing plants at D, E and F with processing capacities of 2000,6000 and 2250 respectively. The transportation costs per tone per mile is €1.5 and the distances in miles between groves and processing plants are

	D	E	F
A	21	50	40
B	35	30	22
C	55	20	25

LG wants to determine how many tones to ship from each grove to each plant in order to minimize the total cost.

1. Formulate on paper an LP model for this problem?
2. Solve the problem using Gurobi.
3. What is the optimal solution?

**Question 5:** Minimum design manufactures lighting products and is about to determine its plan for production and inventory levels for the following 6 months. There are seasonal fluctuations in the prices of raw materials and therefore the production costs are not constant. Production capacity also differs from month to month due to differences of working days, vacations and scheduled maintenance and training. The current inventory of MD is 1800 units. Items that are stored in Inventory at the end of the month incur an inventory cost of €4. At most 6000 units can be held in inventory at any time. To maintain a stable workforce MD wishes to produce at least 50% of its production capacity every month. Furthermore MD wants to keep at least 1500 units in inventory as safety stock to serve unexpected demand.

	Months					
	1	2	3	4	5	6
Unit production cost (€)	250	253	255	253	250	255
Demand	1000	4500	6000	4500	3500	4000
Maximum Production	4000	3500	4000	4500	4000	2500

1. Formulate on paper an LP model to determine the optimal production plan?
2. Solve the problem using Gurobi.
3. What is the optimal solution?

**Question 6:** *As greek as it gets* is a small but growing restaurant chain specializing in Souvlaki. AGAIG is planning to open a new restaurant in Utrecht and wants to establish a construction fund to pay for the new facility. Construction is expected to take 6 months and costs €800,000. Of these, €250,000 have to be paid after 2 months, €250,000 at the end of the 4 months and the remaining €300,000 at the end of the six month period.

AGAIG can use 4 investment options to establish the construction fund. The table below indicates which investments are available in each month, their time to maturity and corresponding yield.

Investment	Available in Month	Months to Maturity	Yield at maturity
A	1,2,3,4,5,6	1	1.8%
B	1,3,5	2	3.5%
C	1,4	3	5.8%
D	1	6	11%

AGAIG wished to determine the optimal investment plan to meet the required schedule of payments with the minimum amount of money.

1. Formulate on paper an LP model to determine the optimal production plan?
2. Solve the problem using Gurobi.
3. What is the optimal solution?