Quiz 1 Practice:
Questions: Chapter 2: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10
Reference: *Linear Programming, Ignizio and Cavalier, Prentice Hall, 1994.*

2.1. Two recent graduates have decided to enter the field of microcomputers. They intend to manufacture two types of microcomputers, Comp386 and Comp486. Because of the interest in microcomputers, they can (presently) sell all that they could possibly produce. However, they wish to size the production rate so as to satisfy various estimated limits with a small production crew. These include

Assembly hours: 150 hours per week
Test hours: 70 hours per week

The Comp386 requires 4 hours of assembly and 3 hours of testing, and the Comp486 consumes 6 hours and 3.5 hours, respectively. Profit for the Comp386 is estimated at $300 per unit; that of Comp486 is $450 per unit. Develop a linear programming model that maximizes weekly profit.

2.2. An automotive firm produces three types of cars: a large luxury car, a midsized car, and a compact car. The gasoline mileage figures, predicted sales, and profit figures for each type of car are given in Table 2.5. Government regulations state that the average gasoline mileage for the company's entire line of cars should equal or exceed 30 mile per gallon (mpg). The firm wishes to maximize its profits. Formulate a linear programming model for this problem.

TABLE 2.5.

Car	Mileage (mpg)	Profit/car	Demand
Luxury	18	$600	600,000
Mid-size	29	$460	800,000
Compact	38	$320	700,000

2.3. Greentree Farms owns 500 acres of tillable farmland that is used to grow corn, wheat, soybeans, and oats. On average, each acre of corn, wheat, soybeans, and oats yields 110, 35, 32, and 55 bushels, respectively. In order to receive federal subsidies, no more than 120 acres of soybeans can be planted. At least 10,000 bushels of corn are required due to a contractual agreement with a dairy farm. In addition, the total acreage of wheat should equal or exceed the total combined acreage of oats and soybeans. If a bushel of corn, wheat, soybeans, and oats sells for $0.36, $0.90, $0.82, $0.98, respectively, formulate a linear programming model to determine the optimal acreage of each crop to plant.

2.4. A manufacturing firm needs to schedule the monthly production of two seasonal items for the next 6 months. The unit production cost of Item A is estimated to be \$15 for the first 2 months, \$16 for the third and fourth months, and \$18 for the last two months. The unit production cost for Item B is estimated to be \$8 for the first 3 months and \$10 for the last 3 months. The monthly demands for Item A are 200, 250, 400, 650, 700, 450 units, and the monthly demands for Item B are 160, 180, 370, 500, 420, 350 units. The firm can produce a maximum of 800 units per month. Excess production can be stored from one month to the next at a cost of \$2 per unit, but a maximum of 200 total units can be stored in any given month. Assuming that beginning inventory levels are zero, how should the production be scheduled so as to minimize the total costs?

2.5. A refinery produces three grades (A, B, C) of gasolines from three different sources of crude oil (I, II, III). Any crude oil can be used to produce any of the gasolines as long as the specifications in Table 2.6 are met.

TABLE 2.6

Grade of gasoline	Specifications	Selling price/gallon
A	Not less than 50% crude I, not more than 30% crude II	\$1.39
B	Not less than 35% crude I, not more than 45% crude II	\$1.24
C	Not more than 20% crude III	\$1.18

The maximum amount of crude oil available per period and their costs are

Crude I: 10,000 gallons, \$1.10 cost/gallon
Crude II: 9,000 gallons, \$0.84 cost/gallon
Crude III: 3,000 gallons, \$0.90 cost/gallon

The oil refinery naturally wants to maximize profit. Formulate a linear programming model.

2.6. Three different investment options are available at the beginning of each year during the next 6-year period. The durations of the investments are 1 year, 3 years, and 5 years. The 1-year investment yields a total return of 5.1%, the 3-year investment yields a total return of 16.2%, and the 5-year investment yields a total return of 28.5%. If an initial investment of \$10,000 is made and all available funds are invested at the beginning of each year, formulate a linear programming model to determine the investment pattern that results in the maximum available cash at the end of the sixth year.

2.7. PDQ Manufacturing Company produces two products, widgets and gadgets. Each widget and gadget requires several basic machining operations to produce. PDQ has five different machining centers, and some of the required machining operations can be performed at more than one of the centers. Consequently, there are several alternative ways of producing each widget and each gadget. Table 2.7 summarizes the unit production times required for the various operations.

TABLE 2.7

		Unit production times (hours)				
Product	Method	Center 1	Center 2	Center 3	Center 4	Center 5
Widget	1	0.25	0.13	—	0.20	—
	2	—	0.34	0.15	—	0.28
	3	0.25	—	0.42	—	—
Gadget	1	—	0.18	—	—	0.32
	2	0.26	—	0.22	—	0.14
	3	0.20	—	—	0.30	—
	4	—	0.12	0.18	0.20	—

The unit cost of widgets produced using Methods 1, 2, and 3 are \$1.35, \$1.28, and \$1.47, respectively. Similarly, the unit cost for gadgets produced using Methods 1, 2, 3, and 4 are \$1.14, \$1.19, \$1.26, and \$1.16, respectively. The weekly demand for widgets and gadgets are 320 and 250, respectively, and each machining center is available for 80 hours per week. Formulate a linear programming problem to find the least-cost production schedule.

2.8. A firm manufactures chicken feed by mixing three different ingredients. Each ingredient contains four key nutrients: protein, fat, vitamin *s*, and mineral *t*. The amount of each nutrient contained in 1 kilogram of the three basic ingredients is summarized in Table 2.8.

TABLE 2.8

Ingredient	Protein (grams)	Fat (grams)	Vitamin *s* (units)	Mincral *t* (grams)
1	25	11	235	12
2	45	10	160	6
3	32	7	190	10

The costs per kilogram of Ingredients 1, 2, and 3 are \$0.55, \$0.42, and \$0.38, respectively. Each kilogram of the feed must contain at least 35 grams of protein, a minimum of 8 grams of fat and a maximum of 10 grams of fat, at least 200 units of vitamin *s*, and at least 10 units of mineral *t*. Formulate a linear programming model for finding the feed mix that has the minimum cost per kilogram.

2.9. C, S, & C, Inc., must decide how much to invest in a number of alternative investment opportunities, which are summarized in Table 2.9.

TABLE 2.9

Investment opportunity	Country	Expected return (%)	Maximum investment (\$ million)
1	United States	9	2
2	Japan	10	12
3	Canada	8	8
4	United States	7	6
5	Kuwait	7	10
6	United States	6	4
7	United States	11	9

Company policy requires that the total amount invested inside the United States should be at least as much as invested outside the United States. In addition, of the total amount invested in North America, at most 20% should be invested in Canada. C, S, & C has \$40 million to invest and obviously wants to maximize its total expected return on investment. Formulate a linear programming model for solving this problem.

2.10. A small foundry needs to schedule the production of four different castings during the next week. The production requirements of each casting are summarized in Table 2.10.

TABLE 2.10

	Unit production times (minutes)				
Product	Pouring	Cleaning	Grinding	Inspection	Packing
A	3	8	10	1	3
B	1	12	6	1	5
C	2	6	9	1	3
D	1	7	7	1	2

The unit profit for Products A, B, C, and D are \$18, \$15, \$13, and \$14, respectively. Current demands indicate that all castings that are made can be sold; however contracts dictate that at least 200 units of Product A and 300 units of Product D be produced. The estimated time available for each of the operations during the next week are

Pouring: 40 hours
Cleaning: 80 hours
Grinding: 80 hours
Inspection: 20 hours
Packing: 40 hours