1. Formulate in mathematical programming and solve graphically the following problem:

   DEG manufactures two types of computers: laptops and desktops. Each computer must go through an assembly line and quality control. The working period is eight hours a day and five days a week. If the assembly line were completely dedicated to laptops, up to 9 computers a day could be assembled. With desktops this limit is 1 computer per hour. If quality control were completely dedicated to notebooks, you could check 10 units a day; with desktops the hourly verification limit is 2 computers. By decision of the marketing department, more laptops than desktops should be produced. Each laptop contributes 250 contos to the profit, and each desktop 150 contos.

2. Farmer Jonas must determine how many acres of corn and wheat to plant this year. An acre of wheat yields 25 bushels of wheat and requires 10 hours of labor per week. An acre of corn yields 10 bushels of corn and requires 4 hours of labor per week. All wheat can be sold at $4 a bushel, and all corn can be sold at $3 a bushel. Seven acres of land and 40 hours per week of labor are available. Government regulations require that at least 30 bushels of corn be produced during the current year. *[source: W.Winston]*

   (a) Let x_1 be the number of acres of corn planted, and x_2 be the number of acres of wheat planted. Using these decision variables, formulate an LP whose solution will tell Farmer Jonas how to maximize the total revenue from wheat and corn.

   (b) Indicate which of the following solutions are feasible:

      i. $(x_1 = 2, x_2 = 3)$
      ii. $(4, 3)$
      iii. $(2, -1)$
      iv. $(3, 2)$

   (c) Using the variables $x_1 =$ number of bushels of corn produced and $x_2 =$ number of bushels of wheat produced, reformulate Farmer Jonas's LP.

   (d) Solve this problem graphically.

3. **Short-Term Financial Planning.** Semicond is a small electronics company that manufactures tape recorders and radios. The per-unit labor costs, raw material costs, and selling price of each product are given in this table:

	Tape recorder	Radio
Selling price	100	90
Labor cost	50	35
Raw material cost	30	40

   On December 1, 2002, Semicond has available raw material that is sufficient to manufacture 100 tape recorders and 100 radios. On the same date, the company's balance sheet is as shown next, and Semicond's asset–liability ratio (called the current ratio) is $20,000/10,000 = 2$.

	Assets	Liabilities
Cash	10000	
Accounts receivable	3000	
Inventory outstanding	7000	
Bank loan		10000

Semicond must determine how many tape recorders and radios should be produced during December. Demand is large enough to ensure that all goods produced will be sold. All sales are on credit, however, and payment for goods produced in December will not be received until February 1, 2003. During December, Semicond will collect $2,000 in accounts receivable, and Semicond must pay off $1,000 of the outstanding loan and a monthly rent of $1,000. On January 1, 2003, Semicond will receive a shipment of raw material worth $2,000, which will be paid for on February 1, 2003. Semicond's management has decided that the cash balance on January 1, 2003, must be at least $4,000. Also, Semicond's bank requires that the current ratio at the beginning of January be at least 2. To maximize the contribution to profit from December production, (revenues to be received) − (variable production costs), what should Semicond produce during December? [source: Winston]

4. **Oil Blending.** Sunco Oil manufactures three types of gasoline (gas 1, gas 2, and gas 3). Each type is produced by blending three types of crude oil (crude 1, crude 2, and crude 3). The sales price per barrel of gasoline and the purchase price per barrel of crude oil are given as follows.

Sales price per barrel		Purchase price per barrel	
G1	70	C1	45
G2	60	C2	35
G3	50	C3	25

Sunco can purchase up to 5,000 barrels of each type of crude oil daily. The three types of gasoline differ in their octane rating and sulfur content. The crude oil blended to form gas 1 must have an average octane rating of at least 10 and contain at most 1% sulfur. The crude oil blended to form gas 2 must have an average octane rating of at least 8 and contain at most 2% sulfur. The crude oil blended to form gas 3 must have an octane rating of at least 6 and contain at most 1% sulfur. The octane rating and the sulfur content of the three types of oil are given in this table:

	Octane rating	Sulfur content
C1	12	0.5%
C2	6	2.0%
C3	8	3.0%

It costs $4 to transform one barrel of oil into one barrel of gasoline, and Sunco's refinery can produce up to 14,000 barrels of gasoline daily. Sunco's customers require the following amounts of each gasoline: gas 1—3,000 barrels per day; gas 2—2,000 barrels per day; gas 3—1,000 barrels per day. The company considers it an obligation to meet these demands. Sunco also has the option of advertising to stimulate demand for its products. Each dollar spent daily in advertising a particular type of gas increases the daily demand for that type of gas by 10 barrels. For example, if Sunco decides to spend $20 daily in advertising gas 2, then the daily demand for gas 2 will increase by $20(10) = 200$ barrels. Formulate an LP that will enable Sunco to maximize daily profits (profits = revenues − costs). [source: W.Winston]

5. Solve the above problems writing a program in the language AMPL/Gnu MathProg and using *GLPK* (i.e., *glpsol* command line).