GRA 6227 – Modeling problems

Problem A

A company produces two products that are processed on two assembly lines. Assembly line 1 has 100 available hours, and assembly line 2 has 42 available hours. Each product requires 10 hours of processing time on line 1, while on line 2, product 1 requires 7 hours and product 2 requires 3 hours. The profit for product 1 is $6 per unit, and the profit for product 2 is $4 per unit.

1. Formulate the decision problem as a mathematical model where the goal is to maximize profit.
   - What are the decision variables?
   - What is the objective function?
   - What are the constraints?

2. Find the optimal solution.

Problem B

The Lakeside Boatworks is planning to manufacture three types of molded fiberglass recreational boats—a fishing (bass) boat, a ski boat, and a small speedboat. The estimated selling price and variable cost for each type of boat are summarized in the following table.

Boat	Variable Cost	Selling Price
Bass	$12,500	$23,000
Ski	8,500	18,000
Speed	13,700	26,000

The company has incurred fixed costs of $2,800,000 to set up its manufacturing operation and begin production. Lakeside has also entered into agreements with several boat dealers in the region to provide a minimum of 70 bass boats, 50 ski boats, and 50 speedboats. Alternatively, the company is unsure of what actual demand will be, so it has decided to limit production to no more than 120 of any one boat. The company wants to determine the number of boats that it must sell to break even while minimizing its total variable cost.

Value of objective function in the optimal solution: 2925.285

Problem C

Betty Malloy, owner of the Eagle Tavern in Pittsburgh, is preparing for Super Bowl Sunday, and she must determine how much beer to stock. Betty stocks three brands of beer—Yodel, Shotz, and Rainwater. The cost per gallon (to the tavern owner) of each brand is as follows.

Brand	Cost/gal
Yodel	$1.50
Shotz	0.90
Rainwater	0.50

The tavern has a budget of $2,000 for beer for Super Bowl Sunday. Betty sells Yodel at a rate of $3.00 per gallon, Shotz at $2.50 per gallon, and Rainwater at $1.75 per gallon. Based on past football games, Betty has determined the maximum customer demand to be 400 gallons of Yodel, 500 gallons of Shotz, and 300 gallons of Rainwater. The tavern has the capacity to stock 1,000 gallons of beer; Betty wants to stock up completely. Betty wants to determine the number of gallons of each brand of beer to order so as to maximize profit.

Value of objective function in the optimal solution: 1525

Problem D

Joe Henderson runs a small metal parts shop. The shop contains three machines—a drill press, a lathe, and a grinder. Joe has three operators, each certified to work on all three machines. However, each operator performs better on some machines than on others. The shop has contracted to do a big job that requires all three machines. The times required by the various operators to perform the required operations on each machine are summarized as follows.

Operator	Drill Press (min)	Lathe (min)	Grinder (min)
1	22	18	35
2	41	30	28
3	25	36	18

Joe Henderson wants to assign one operator to each machine so that the total operating time for all three operators is minimized.
   a. Formulate a linear programming model for this problem.
   b. Solve the model using the computer.
   c. Joe's brother, Fred, has asked him to hire his wife, Kelly, who is a machine operator. Kelly can perform each of the three required machine operations in 20 minutes. Should Joe hire his sister-in-law?

b.

Value of objective function in the optimal solution: 70

c.

Value of objective function in the optimal solution: 56

Problem E

A manufacturing company – Company X - purchases a given component from a supplier.

Purchasing price is 10 per unit.

To keep the component on inventory at the Company X's production site costs 3 per unit per month.

Company X's estimated consumption of the component for the six first months is given in the following table:

Month	1	2	3	4	5	6
Demand	270	480	520	540	660	770

The supplier has a limited capacity, as given by the following table:

Month	1	2	3	4	5	6
Supplier's capacity	650	650	650	500	650	650

The company wants to set up a plan for the purchases throughput the 6-month period, i.e., how much to purchase in each month. All estimated consumption must be covered in the plan.

Before month 1, there is an inventory of 150 unit.

Company X requires that the inventory level by the end of month 6 must be at least 100 units.

a) Formulate an optimization model that minimizes the sum of purchasing and inventory holding costs for the entire period.

b) In month 3, a second supplier will have 200 units of the same type of component available for company X, at a price of 12,50 per unit. Should company X purchase anything from the second supplier? If so, how much? Modify the optimization model so that it fits this new situation.