IE 400 - PRINCIPALS OF ENGINEERING MANAGEMENT

2017-2018 Fall

Study Set 3

1) Dr. Kripke is the manager of an institution called Nodlehs which is producing clothes. The institution has a small factory where no automated vehicles are used. All the products are hand made. So, the production process consists of only human labor force. The customers submit their orders beforehand and Dr. Kripke has taken the orders for the months January,February,March and April. The demand of each month is given in the following table.

	January	**February**	**March**	**April**
Demand (*pieces*)	72	125	190	93

Nodlehs currently (by January 1st) employs 7 workers. Each worker can produce 12 clothes per month. Monthly salary of a worker is $400. Hiring new workers costs $100 per new worker due to training. Dr. Kripke has to pay $200 to each worker he sacks as a compensation. He sells each piece of clothing for $50. Dr. Kripke wants to protect his goods against burglary. So, he employs a security guard to watch the products in the inventory over the nights. The security guard is paid $10 per item he protects at the end of a month. Model Dr. Kripke's profit maximization problem over the 4 months by using integer linear programming.

2) Amy is a cashier working at a supermarket who wants to know the smallest possible number of coins to return when a customer buys for X money units and gives Y money units to the cashier (X and Y are integers and $Y \geq X$). Let C= {1, 2, ..., n} be the set of coins and let vi denote the value of coin i. Assume that v1=1 and v2, ..., vn are arbitrary positive integer values. (In particular, in TLs, n=6 and we have v1=1, v2=5, v3=10, v4=25, v5=50, and v6=100). Formulate Amy's problem as an integer linear programming problem with the following constraints. You are free to define additional variables if necessary.

- At least two different types of coins must be used.
- If coin type 3 is used then coin type l should not be used.
- Either both coin types 4 and 5 are used or neither of them is used.
- Either at least two types of coins from the group { v1, v2, v3, } or at most two types of coins from the group {v4, v5, v6} must be chosen.

3) Penny wants to produce Penny Blossoms (some kind of accessory) and sell them to gain some money. To produce a unit of Penny Blossoms, the raw material must undergo 4 different processes. (In the order of Process 1, Process 2, Process 3, Process 4. After process 4 is done, 1 unit of product is fully manufactured.) Luckily, Penny has four lovely friends Leonard, Sheldon, Howard, Raj to help her. So, Penny decides to assign each friend to a single process so that she can construct an assembly line which runs manufacturing process faster. However, each friend's performance varies upon the process they are assigned to. Their performance table shows who can handle one unit of product on which process in how much time.

(minutes per item)	**Process 1**	**Process 2**	**Process 3**	**Process 4**
Leonard	5	8	9	10
Sheldon	10	12	10	8
Howard	7	10	8	9
Raj	10	13	9	11

Penny's goal is to minimize the cycle time per unit. Formulate Penny's problem as an integer programming problem.
(Cycle time per unit: The time interval between parts coming off the line.)

(Hint 1: For an assembly line, the cycle time is equal to the processing time of the slowest person in that particular line.)
(Hint 2: $\max(x_1,x_2,\ldots\ldots,x_n)$ is not a linear function)

4) Solve the following knapsack problem.

$$\max \quad 7x_1 + 3x_2 + 8x_3 + 4x_4 + 12x_5 + 3x_6$$

$$4x_1 + 2x_2 + 5x_3 + 3x_4 + 7x_5 + 3x_6 \leq 15$$

$$x_1, x_2, x_3, x_4, x_5, x_6 \in \{0,1\}$$