Department of Chemical Engineering
Auburn University
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CHEN 4460
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OPTIMIZATION HOMEWORK

Turn in at lecture Tuesday November 1

PROBLEM 1

A chemical plant consists of two processes which use ammonia as a raw material. The first process produces urea while the second one yields ammonium nitrate. The net profits for producing urea and ammonium nitrate are 1,100 and 1,600 $/ton produced, respectively. Each process consists of two steps; reaction and drying. The man-hours needed for each step per ton produced of each chemical are given in the table below.

	Man-hours per ton of Urea	Man-hours per ton of Ammonium Nitrate
Reaction	4	2
Drying	2	5

Available for service are 80 man-hours per week for the reaction steps of both processes and 60 man-hours per week for the drying steps of both processes. Due to process losses, each ton produced of either chemical requires four tons of ammonia feed. The maximum supply of ammonia to the plant is 75 tons/week.

1. Formulate an optimization problem that maximizes the net profit of the plant.
2. Explain the objective function and the constraints.
3. Solve the optimization problem in LINGO to identify the maximum net profit and the optimal production rate of each of the two chemicals.

PROBLEM 2

Another chemical plant consists of two processes which use ammonia as a raw material. The first process produces urea while the second one yields ammonium nitrate. The net profits for producing urea and ammonium nitrate are 1,100 and 1,600 $/ton produced, respectively. Each process consists of two steps; reaction and drying. The man-hours needed for each step per ton produced of each chemical are given in the table below.

	Man-hours per ton of Urea	Man-hours per ton of Ammonium Nitrate
Reaction	5	3
Drying	5	6

Available for service are 60 man-hours per week for the reaction steps of both processes and 75 man-hours per week for the drying steps of both processes. Due to process losses, each ton

produced of either chemical requires four tons of ammonia feed. The maximum supply of ammonia to the plant is 45 tons/week.

1. Formulate an optimization problem that maximizes the net profit of the plant.
2. Solve the optimization problem in LINGO to identify the maximum net profit and the optimal production rate of each of the two chemicals.

PROBLEM 3

The two plants described in problems (1) and (1) are now owned by the same person who is trying to maximize the combined net profit of both plants. The owner has relaxed the restrictions on ammonia supply to each plant (originally 75 tons/week for the first plant and 45 tons/week for the second plant). Nonetheless, the owner can provide a maximum combined supply of ammonia to both plants of 120 tons/week. Therefore, he has to optimally distribute the available ammonia between the two plants.

1. Formulate an optimization problem maximizing the combined net profit of the two plants.
2. Solve the optimization problem in LINGO to identify the maximum combined net profit and the optimal production rate of each of the two chemicals.
3. What is optimal distribution of the available ammonia between the two plants?
4. Compare the combined maximum net profit for the two plants with the results obtained for the individual plants in problems (1) and (2) and comment on the difference (if any).