24.2.11 (AN)
ABUA

AGRICULTURAL AND FOOD ENGINEERING DEPARTMENT
INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Date of Examination: 24.02.2011 (AN) **Time: 2 h**
Mid-Spring Semester, 2011 **Full Marks: 30**
M.Tech. in ASM
Sub. No. and Name: AG60064; Systems Approach in Agriculture
No. of Students: 7 (M.Tech.) and 3 Ph.D of the Dept. of Agril. & Food Engg.
Instructions: Attempt all questions. Make reasonable assumptions, if necessary.

Q1. A fertilizer company has only 1,000 tonnes of nitrate, 2,000 tonnes of phosphate and 500 tonnes of potash available per month. It uses these to make three basic fertilizers, namely 5-5-5, 5-10-5, and 10-10-5, where the numbers in each case represent the percentage by weight of nitrate, phosphate and potash in each of the mixtures. The cost of materials is

Ingredient	Nitrate	Phosphate	Potash	Inert ingredients
Cost (Rs./tonnes)	900	260	600	40

The three fertilizers sell at Rs. 350, Rs. 300, and Rs. 450 per tonne, respectively. There is a constraint that at least 5,000 tonnes of 5-10-5 fertilizer must be produced per month. Formulate a L.P model to determine the amount of each fertilizer that must be produced per month to maximize the monthly profit.

(5)

Q.2. Solve the following L.P. problem by the revised simplex method:

Minimize: $Z = 3X_1 + 2X_2 + 4X_3 + 6X_4$

Subject to: $X_1 + 2X_2 + X_3 + X_4 \geq 1000$
$2X_1 + X_2 + 3X_3 + 7X_4 \geq 1500$
$X_1, X_2, X_3, X_4 \geq 0$

(8)

Q.3. A tractor rental company is faced with an allocation problem resulting from rental agreements that allow tractors to be returned to locations other than those at which they were originally rented. At present, there are two locations (sources) with 9 and 16 surplus tractors, respectively, and four locations (destinations) requiring 9, 6, 7, and 9 tractors, respectively. Unit transportation costs (in Rupees) between the locations are as follows:

	Dest. 1	**Dest. 2**	**Dest. 3**	**Dest. 4**
Source 1	42	33	18	20
Source 2	25	36	28	40

(a) Find an initial basic feasible solution to the above transportation problem using the north-west corner rule.
(b) Starting with the above initial basic feasible solution obtained using the north-west corner rule, find the minimum cost schedule for the transportation problem.

(8)

Q.4. A factory manufactures 3 products. Three resources – technical services, labour and administration – are required to produce these products. In order to determine the optimal product mix which will maximize the total profit (in Rs.), the following linear program was solved:

Maximize: $Z = 10X_1 + 6X_2 + 4X_3$

Subject to:

$$X_1 + X_2 + X_3 \leq 100 \quad \text{(Technical)}$$
$$10X_1 + 4X_2 + 5X_3 \leq 600 \quad \text{(Labour)}$$
$$2X_1 + 2X_2 + 6X_3 \leq 300 \quad \text{(Administration)}$$

$$X_1, X_2, X_3 \geq 0$$

where X_1, X_2, and X_3 are the number of product 1, product 2, and product 3 produced. The optimal solution is given by the following tableau, where X_4, X_5, and X_6 are the slack variables:

C_j / Basis	10 X_1	6 X_2	4 X_3	0 X_4	0 X_5	0 X_6	Constants
X_2	0	1	5/6	10/6	- 1/6	0	400/6
X_1	1	0	1/6	- 4/6	1/6	0	200/6
X_6	0	0	4	- 2	0	1	100
$\bar{C}$ Row	0	0	- 16/6	- 20/6	- 4/6	0	Z = 4400/6

Using sensitivity analysis, answer the following with respect to the above optimal tableau:

(i) What should be the profit of product 3 before it becomes worthwhile to manufacture? Find the most profitable product mix as well as the maximum profit if the profit on product 3 were increased to Rs. 8.

(ii) What is the range on the profit of product 2 so that the current solution is still optimal?

(iii) It is believed that the estimates of the available hours of technical services might be wrong. The correct estimate is $100 + 10\lambda$ where λ is some unknown parameter. Find the range of values of λ within which the optimal basis remains the same.

(iv) Determine the shadow prices of all the resources.

(v) The manufacturing department comes up with a proposal to produce a new product requiring 3 hours of technical service, 4 hours of labour, and 1 hour of administration and the product can be sold at a unit profit of Rs. 8. What should be the management's decision?

(9)

GOOD LUCK!