AGRICULTURAL AND FOOD ENGINEERING DEPARTMENT
INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Date of Examination: 20.04.2018 (AN) **Time: 3 h**
End-Spring Semester, 2018 **Full Marks: 50**
M.Tech. in LWRE
Sub. No. and Name: AG60042; Water Resources System Analysis
No. of Students: 21 (M.Tech. LWRE (17), B.Tech. and Dual Degree (4))

Instructions: All questions are compulsory. Make reasonable assumptions, if necessary. NORMAL TABLE MAY BE USED.

Q1. A combination of three technologies is used to remove a certain pollutant from wastewater. The three technologies remove 1, 2, and 3 g/m^3 of the pollutants, respectively. The third technology variant seems to be the best, but it cannot be applied to more than 50% of the wastewater being treated. The costs of applying the technology variants are Rs. 2, Rs. 3, and Rs. 5 per cubic meter, respectively. If exactly 1000 m^3 must be treated in a day, and at least 1.5 g/m^3 of pollutant has to be removed, then formulate a LP model to minimize the costs and solve it.

(8)

Q2. 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.

(7)

Q3. A project with 9 jobs has the following information.

Activity	Preceding Activity	Time (days)		Cost (Rs.)	
		Normal	Crash	Normal	Crash
A	-	10	9	5000	5200
B	-	14	11	3500	3950
C	A	8	7	4000	4100
D	A	7	2	2100	3600
E	B	5	3	2500	3000
F	B	10	7	2250	3750
G	C	9	9	5000	5000
H	D, E	11	9	3850	5250
I	G, H	5	3	2375	3575

Assuming the cost-time relation to be linear and the overhead cost as Rs. 600 per day, determine

(a) the optimal duration of the project in terms of the total cost (i.e. both crashing and overhead costs)

(b) the crashing schedule that will meet the project deadline of (i) 29 days and (ii) 28 days at minimum total cost (i.e. both crashing and overhead costs).

(8)

Q4. Use Big M method to solve the following LP problem:

Maximize $Z = 2X_1 + 3X_2 + 4X_3$

Subject to $3X_1 + X_2 + 4X_3 \leq 600,$
$2X_1 + 4X_2 + 2X_3 \geq 480,$
$2X_1 + 3X_2 + 3X_3 = 540,$
$X_1, X_2, X_3 \geq 0$

(6)

Q5. The time estimates (in weeks) for the activities of a PERT network are given below.

Activity	t_o	t_m	t_p
1-2	1	1	7
1-3	1	4	7
1-4	2	2	8
2-5	1	1	1
3-5	2	5	14
4-6	2	5	8
5-6	3	6	15

(a) Determine the expected project length and its variance.

(b) What is the probability that the project will be completed within 22 weeks?

(c) What should be the scheduled completion time for the probability of completion to be 90%?

(7)

Q6. Use Lagrange method to

Minimize: $Z = (x_1 - 1)^2 + (x_2 - 2)^2$

Subject to: $x_1 - 2x_2 = 0$

(6)

Q7. Use Kuhn-Tucker conditions to

Minimize: $f(x) = (x_1 - 1)^2 + (x_2 - 0.8)^2$

Subject to: $x_1 - x_2 \geq 0$

$-x_1^2 + x_2 \geq 0$

$x_1 + x_2 \geq 1$

(8)

GOOD LUCK!