Indian Institute of Engineering Science and Technology, Shibpur
M.E. (Civil) Second Semester Examination, May, 2014
Sub: Water Resources Systems Planning and Management (CE-1014)

Time: Three hours **Full Marks: 70**

Answer any four from the following. Figures in the margin indicate full marks. Two marks are reserved for neatness.

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1. Solve the following problem using simplex method

   i) Maximize $z = 3x_1 + 4x_2$

   Subject to
   $5x_1 + x_2 \geq 45$
   $3x_1 + 5x_2 \leq 72$
   $2x_1 + x_2 \leq 24$
   $x_1, x_2 \geq 0$

2. Solve the following

   i) Minimize $f(X) = (x_1 - 2)^2 + (x_2 - 2)^2$

   Subject to
   $x_1 + 2x_2 \leq 3$
   $8x_1 + 5x_2 \geq 10$

   ii) Minimize $f(X) = x_1^2 + x_2^2$

   Subject to
   $x_1 + x_2 = 4$
   $2x_1 + x_2 \geq 5$

3. Four reservoirs are in a network. Reservoirs (1, 3) and (2, 4) are in series and reservoirs (3, 4) are in parallel. Draw the network. Describe the optimization problem in DP framework: – i) for reservoirs (1, 3) only, ii) for reservoirs (3, 4) only, considering releases from the upstream reservoirs 1 and 2 as a part of their respective inflows, and iii) considering all the reservoirs simultaneously. (Note: Use a benefit function B_t, and maximize the cumulative benefits. Write the recursive equations, system dynamics and constraints only, for each of the cases above.) (17)

4. Consider optimal monthly operation of a single reservoir having the following characteristics: - $S_{max} = 50$, $S_{min} = 10$; $R_{max} = 30$, $R_{min} = 0$. Average monthly inflows to the reservoir are as follows: -

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Inflow (m³/s)	22	18	11	8	0	33	45	58	72	47	39	30

   If the loss function is given by $P_t = (20 - R_t)^2$, derive the backward solution using discrete dynamic programming for December and November. Use R_t as control variable. (17)

5. Solve the reservoir operation problem of Q4. using S_{t+1} as control variable. (17)

6. Determine the optimal benefit and optimal allocation sequence x_j^*, j=1, ..., 3, for the following optimization problem using Dynamic Programming technique (Q = 3 units). (17)

   Maximize $\sum B_j(x_j)$

   $0 \leq x_j \leq Q$, j=1,…,3, where $B_j(x_j)$ is as follows:

x_j	0	1	2	3
B_1	0	-0.25	3.5	6.5
B_2	0	5.8	10.5	14.0
B_3	0	-6.5	-0.8	5.0

7. a) Describe the *curse of dimensionality* associated with Discrete Dynamic Programming.

   b) In order to alleviate the curse of dimensionality, Discrete Dynamic Programming (DDDP) is used. Draw a neat sketch of the *corridor* and describe the method. Also discuss how it helps in alleviating the dimensionality problem. (4+13)

8. Rice and Bajra are grown on a land of 200 ha. The cost of growing Rice per hectare is Rs. 3 lakhs and that of Bajra is Rs. 2 lakhs. Gross benefits from these crops are Rs. 5 lakhs/ha and 3 lakhs/ha respectively. The available budget is Rs. 3 crores. Determine the optimal cropping pattern using Linear Programming. (17)