WATER RESOURCES SYSTEMS

***Time**: Three Hours*

***Maximum Marks**: 100*

Answer five questions, taking ANY TWO from Group A, any two from Group B and all from Group C.

All parts of a question (a, b, etc.) should be answered at one place.

Answer should be brief and to-the-point and be supplemented with neat sketches.

Unnecessary long answer may result in loss of marks.

Any missing or wrong data may be assumed suitably giving proper justification.

Figures on the right-hand side margin indicate full marks.

Group A

1. (a) What do you understand by the term "system"? 6

   (b) Enlist the factors that characterize a system. 6

   (c) Describe various methods for estimation of missing rainfall data for a rain gauge station. 8

2. (a) There are seven rain gauge stations in a catchment. The normal annual rainfalls are known and given in the following table. In 2010, because of some unforeseen reason, one rain gauge became inoperative. The other rain gauges recorded their annual rainfalls that are also given in the following table. Estimate the missing annual rainfall by using arithmetic averaging and normal ratio methods. 8

Station	Normal annual rainfall, cm	Recorded annual rainfall, cm
X1	136.6	145.7
X2	160.7	158.1
X3	164.6	163.4
X4	155.5	157.7
X5	145.3	140.4

X6	160.7	163.8
X7	158.8	Missing

(b) A hilly basin of area 1200 km^2 has 7 rain-gauge stations. The annual rainfalls observed in these stations are 62, 95, 60,49, 36, 85 and 72. Determine the optimum number of gauges required in the basin, if it is desired to limit the error in mean rainfall to 10%. Also, state the number of gauges required as per IS recommendation. 6

(c) Write a note on testing the Goodness of fit by using Chi square test. 6

3. (a) The annual flow of a river for 10 years is given in the following table: 8

Year	**Flow, MCM**
1990	780
1991	220
1992	430
1993	590
1994	200
1995	350
1996	840
1997	600
1998	1390
1999	740

Compute the mean annual flow, their standard deviation and the coefficient of variation.

(b) Write an explanatory note on "optimization techniques" as used in water resources systems. 6

(c) What is Lagrange multiplier method? How this is used in planning of water resources systems? 6

4. (a) What do you understand by simulation? List and briefly describe the advantages and limitations of simulation. 6

(b) Using simplex algorithm solve the following linear programming problem: 8

$$Max\ F = 1x_1 + 2x_2 + 3x_3$$

Subject to
$$1x_1 + 1x_2 + 1x_3 \le 5$$
$$2x_1 + 3x_2 + 4x_3 \le 24$$

(c) What is dynamic programming? How is this used in planning water resources systems? 6

Group B

5. (a) What is water demand forecasting? Explain its importance in water resources development. 6

(b) Presuming that all possible water uses - irrigation, municipal and industrial supply, hydroelectric power, navigation, recreation, enhancement of fisheries and wildlife, and the control functions, i.e., flood and pollution mitigation are pertinent, outline the steps required to prepare a plan for water resources development. 8

(c) Explain the terms : decision under certainty and decision under risk. Give examples. 6

6. (a) What do you understand by “economic life of a project” and “physical life of a project”. 6

(b) List different discounting techniques. Explain briefly any one. What are their advantages and disadvantages? 8

(c) With reference to a multipurpose project, define the terms: separable costs, joint costs, distributed costs and specific costs. 6

7. (a) Eight water resources projects are under consideration. The estimated annual costs and annual benefits for the project are as follows: 10

Project	Av. annual cost (Crores)	Av. annual benefits (Crores)
P	65	78
Q	48	59
R	27	39
S	105	119

T	40	61
U	71	70
V	39	52
W	70	81

Which project should be built if budgetary limitations restrict the annual costs to Rs. 75 crores?

(b) Describe the process of determining the capacity of a reservoir to meet a specified demand pattern using sequent peak algorithm. What are assumptions and disadvantages (if any) of this method. 10

8. (a) The inflow to a proposed reservoir for 12 months are given as: 8, 45, 227, 186, 93, 48, 17, 47, 76, 4, 1 and 0 million m^3 (MCM). If a constant release of 30 MCM is desired from this reservoir, find out the required storage capacity using the sequent peak method. 10

(b) Write a short note on reservoir loss. 10

Group C

9. Answer the following in brief: 20

(i) What are the standard form of a linear programming problem in algebraic and matrix-vector form ?

(ii) Explain the term 'project' in the light of water resources development.

(iii) Enlist various applications of remote sensing in hydrology and water resources.

(iv) The choice of a particular type of hydro-power plant at a given site depends upon various factors. What are these factors ?

(v) Express the standard and matrix-vector representation of primal-dual problems in symmetric form.

(vi) Distinguish between a 'deterministic system' and a 'stochastic system'.

(vii) A LP problem has all equality constraints. The number of constraints is the same as the number of decision variables. How does the solution change with a change in the coefficients (of decision variables) in the objective function ?

(viii) What is the main difference between an ordinary rain gauge and a self-recording rain gauge ?

(ix) What is the velocity-area method and what does it compute ?

(x) What do you understand by 'environmental impact assessment' and name two methods used for it?

(Refer our course material for answers)