M.E. (Water Resources & Hydraulic Engineering) Examination, 2018

(First Year-2nd Semester)

WATER RESOURCES MANAGEMENT

Time: Three Hours Full Marks: 100

Answer any ***four*** questions

1. (a) The following alternative plans for reducing flood damages along a reach of a river are being constructed.

Plan 1 – Channel improvements consisting of widening and straightening the river reach

Plan 2 – Flood retarding dam A

Plan 3 – Flood retarding dam B, which is at the same site but is larger than dam A

Plan 4 – Both the channel improvements and dam A

Plan 5 – Both the channel improvements and dam B

The initial construction and related investment costs and average annual operation and maintenance costs for each plan are tabulated in column 2 and 3 below of Table 1. Without implementation of flood control improvements, average annual flood damages of Rs.5,25,00,000 per year are expected to occur. The channel improvements and dam will reduce the average annual flood damages to the estimated amounts in column 4. The discount rate is 7%. A 50 – year period of analysis has been adopted.

(a) Select the optimum plan based on the objective of minimizing total annual cost.

(b) Select the optimum plan based on the objective of maximizing net benefits.

(c) Select the optimum plan based on an incremental benefit – cost ratio analysis.

Table 1: Total Annual Cost Comparison

Flood control plan	**Initial Investment**	**Operation & Maintenance cost**	**Average annual damages**	**Annual worth of investment**	**Total annual cost**
	(Thousand of Rs)	(Thousand of Rs)	(Thousand of Rs)	(Thousand of Rs)	(Thousand of Rs)
No Project	0	0	52500	0	52500
Plan 1	38000	12500	31200	2754	46454
Plan 2	162000	7700	23800	11739	43239
Plan 3	197000	11300	15600	14275	41175
Plan 4	200000	20200	12500	14492	47192
Plan 5	235000	23800	8300	17028	49128

(b) An impulse turbine is to be installed at a point where 3.1 km of pipeline will be required. The available head is 365 m and the turbine capacity is 2 m^3/s. The turbine will operate 290 days/ year at full load and 70 days/year at half load and will be out of operation 5 days per year. Turbine efficiency is 85% at full load and 82% at half load. If the steel pipe will cost Rs. 300 per kg and the power produced by the turbine is worth Rs 6 per kWh for 4.0 hrs each day, what is the most economical pipe size? Assume a 30 years life for the installation and 8.5% minimum attractive return. Neglect water hammer and assume pipe of constant thickness. Assume density of MS pipe is 7860 kg/$m^3$and wall thickness of the pipe is 10 mm.

14+11=25

2. (a) Define drought. Classify different types of drought with scales.

(b) What are the components of a hydrological drought? Discuss different methods for identification of hydrological drought events.

(c) Discuss salient features of National Water Policy.

5+10+10=25

3. (a) What is Rooftop Rainwater Harvesting (RTRWH)? State some needs for RTRWH with advantages.

(b) There are three types of roof in the office building namely administrative building roof, car park with RCC roof and cycle stand with asbestos roof having individual areas 250 m^2, 160 m^2 and 80 m^2 respectively. The average rainfall is considered as 1650 mm. Assume rate of filtration = 2520 Lt/hr/m^2; average recharging depth = 60 m; Length and diameter of strainer = 30 m and 200 mm. Design RTRWH and recharging with sketches.

8+17=25

4. (a) What are the different types of uncertainties in Water Resources Engineering Projects? What is hydrologic and hydraulic uncertainty?

(b) Apply the first order analysis to Manning's equation for full pipe flow given as-

$$Q= (0.311/n) * S^{1/2} * D^{8/3}$$

To determine for computing equations for mean, standard deviation and coefficients of variation of Q. Consider the diameter D to be deterministic without any uncertainty, and consider n and S to be uncertain

Determine the mean capacity of a storm sewer pipe, the coefficient of variation of the pipe capacity and the standard deviation of the pipe capacity using Manning's equation for full pipe flow.

Parameter	Mean	Coefficient of variation
n	0.017	0.02

D	1.8	0
S	0.002	0.07

Where n, D and S for SI units and Q is in m^3/s

(c) The flow rate Q for a sharp crested weir can be expressed as $Q = C_d\ LH^{3/2}$ where, C_d=Co-efficient of discharge, L= Length of weir crest, H= head of the weir.

The variables L, H are subjected to measurement of errors. The mean and coefficient of variation are as follows,

Parameter	Mean	Co-efficient of variation
L	12 m	0.5
H	2.5 m	0.7

Use first-order uncertainty analysis, to estimate the mean and standard deviation of Q using C_d =0.85

7+10+8=25

5. (a) The decision problem is to determine the amount of land to be planted in crop A and crop B that will maximize income within the constraints of limited land and water resources. Twenty million m^3 of water is available in storage for irrigation of the two crops. Crop A requires 9000 m^3 of water per ha of irrigated land and produces a net income of Rs.28000 per ha. Crop B requires 6000 m^3 per ha and produces a profit Rs. 48000 per ha. Crop A is limited to 1600 ha. Up to 2400 ha of land is available for planting crop B. Formulate the linear programming model and also to determine the amount of land in ha that will maximize income.

(b) An industrial water demand of 10000 m^3 during a particular time period is supplied by withdrawals from two sources: (i) a groundwater aquifer and (ii) a reservoir on a river. The TDS concentrations in the aquifer and reservoir are 980 and 100 mg/L respectively. The maximum allowable TDS concentration is 500 mg/L for the water use being supplied. The capacities of the well and reservoir diversion structure constraint withdrawals, during the time period, to not exceed 6000 m^3 and 10000 m^3, respectively from the aquifer and reservoir. Formulate the model using linear programming method and also to obtain the optimum solution of withdrawing from aquifer and reservoir that will minimize TDS.

13+12=25

6 (a) Identify the key elements of Integrated Flood Management in the context of an Integrated Water Resource Management.

(b) A total of 8 unit of water is to be allocated optimally to three users .The allocation is made in discrete steps of 1 unit ranging from 0 to 8. With the 3 users denoted as user 1, 2 & 3 respectively, the returns obtained from the users for a given allocation are given in the following table

Amount of water allocated	Returns from		
	User1(R_1 X)	User 2(R_2 X)	User 3(R_3 X)
0	0	0	0
1	3	5	7
2	5	6	12
3	8	3	15
4	9	-4	16
5	8	-15	15
6	5	-30	12
7	3	-35	7
8	0	-40	0

Obtain the optimum sequence for water allocation and maximum benefit

5+20=25

7. (a) A corporation has 5 x 10^6 INR to allocate to its 3 water treatment plants for possible expansion each Water Treatment Plant has submitted a numbers of proposals on how its intend to spend the money. Each proposal gives the cost of expansion (C) and the total revenue expected (R). Formulate the problem and also to find optimum allocation to the three Water Treatment Plants such that the total returns will be maximum.

Investment Possibilities

Proposal	User 1		User 2		User 3	
	C_1	R_1	C_2	R_2	C_3	R_3
1	0	0	0	0	0	0
2	1	5	2	8	1	4
3	2	6	3	9	-	-
4	-	-	4	12	-	-

All values are to be multiplied by 10^6 for both C and R

(b) Determine the shortest route for a pipe line for the community among various possible routes to be laid in the field available from destination to source as shown in figure. All pipe length values are in km. using dynamic programming method.

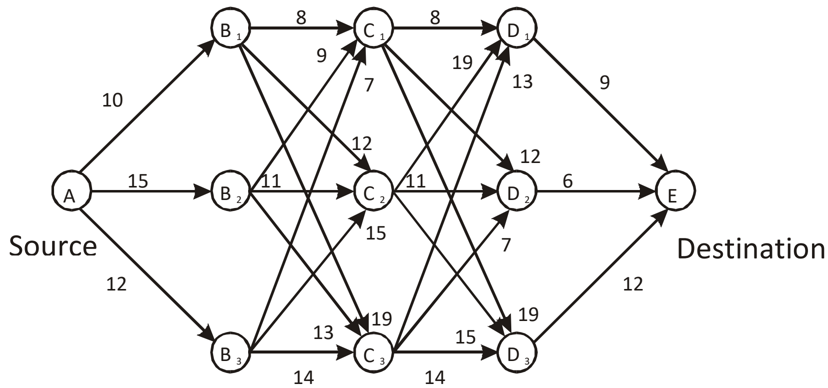

Fig: Network of routes

15+10=25