M.E. WATER RESOURCES AND HYDRAULIC ENGG.
FIRST YEAR SECOND SEMESTER - 2024

WATER RESOURCES MANAGEMENT

(Paper - IV)

Time: Three Hours | Full Marks: 100

Answer any ***four*** questions

1. (a) In Godavari River basin, the available water was allocated for the purposes of consumption, irrigation and electric power supply among three communities. The water allocated per annum per capita for all uses in these communities are $10m^3$, 10m3 and 30 m^3. The allocations were made based on the critical factors of population, land area and the industrialization. The populations of the communities are 300, 200, and 100, power supply capacities are 20W, 10W and 20W while the land areas for irrigation are 50 hectares, 40 hectares and 30 hectares respectively. Allowable allocations limits of more than 300, 100 and 80 were stipulated for the purposes. Using the above information, formulate, (i) Linear Programming Model for the basin. (ii) Maximization the allocations made by simplex method or graphical method. Assume non-negativity condition.

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

20+5=25

2. (a) Inflows during four seasons in a reservoir with storage capacity of 4 units are respectively 2, 1, 3 and 2 units. Only discrete values 0, 1, 2, 3, 4..... are considered for storage and release. Overflows from the reservoir and also included in the release. Reservoir storage at the beginning of the year is 0 unit. Release from the reservoir in a season from the following benefits which are same for all the four seasons.

Release	Benefits
	-100
1	260
2	330
3	490
4	530
5	530
6	420
7	130

Obtain the optimum sequence for a reservoir operation and maximum benefit.

(b) There are three types of roofs in the office building namely administrative building roof, car park with RCC roof and cycle stand with asbestos roof having individual areas 600 m^2, 290 m^2 and 85 m^2 respectively. Assume rate of filtration = 2630 Lt/hr/m^2; average recharging depth = 55 m. Estimate total water available that could be harvested (both rainy and non-rainy season) and also design RTRWH and recharging with sketches.

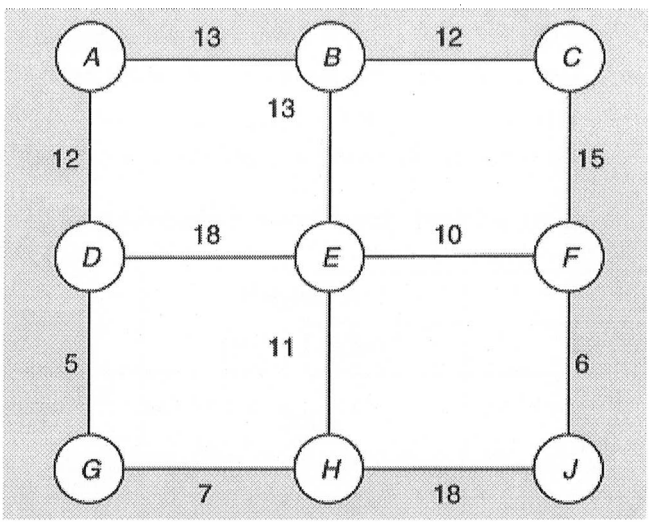
{Monsoon period (80% of the rainfall considered to be occurred during rainy days and 20% in other days of the year); Rainfall to be harvested from the rooftop after allowing the diversion of the first rain = 80%}. Assume any other data if needed.

12.5+12.5=25

3. (a) Distinguish between bed load, suspended load and wash load. What is Saltation?

(b) State two empirical equations for the soil loss due to Sheet and Rill erosion and describe them with each parameter. State two functions of trap efficiency.

(c) A pipeline is to be laid between node G and node C shown in the figure below. The pipeline can pass only along the routes shown by solid lines between intermediate nodes in the figure. The distance between two nodes is shown on the line joining the two nodes. Obtain the shortest distance for the pipeline using dynamic programming. (All length in km.)



6+6+13=25

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

(b) Deduce an expression of pipe capacity for full pipe flow which is used in the Manning's equation where Manning's roughness and longitudinal slope are uncertain.

(c) A reservoir has a capacity of 10 Mm^3 and is fed by a catchment of area 250 km^2. Mean annual runoff at the site is 400 mm. The annual sediment yield and the specific weight of the sediment deposits are estimated to be 1000 tons per km^2 and 12 KN/m^3 respectively. Calculate the time it will take for the reservoir to fill up with sediments. The trap efficiency may be approximated by

$$y = 100\left(1 - \frac{1}{1+100w}\right)^{1.5}$$

5+5+15=25

5. (a) Derive a relationship between the present worth and future sum of money at the end of the n^{th} year for the interest rate i per annum (expressed as a decimal fraction).

(b) A pumped storage plant (PSP) is planned to transfer water back and forth between two reservoirs. A single pump-turbine (PT) will be used. Preliminary calculations indicate that as a pump the PT will deliver water at the rate of 10 m^3/s against a net head of 110 m. Estimates of efficiencies of the PT and motor-generator (MG), when acting as pump and motor, are 0.83 and 0.86 respectively. When acting as a turbine the PT will deliver 12000 hp to the generator shaft. As a generator, the MG is assumed to have an efficiency of 0.92. Enough storage is available in the reservoirs to permit the PT as a pump for 4.0 hrs each day. This same value of water will pass through the PT when acting as a turbine in 3.4 hrs. if the electricity i.e. generated for peaking purposes has a value of Rs. 7/kWh, the off-peak power used for pumping, has a cost of Rs. 2/kWh and the annual cost of operation and maintenance estimated to be Rs. 6 crores per year, how much money can be justifiably invested in the project assuming a project life of 30 years and an interest of 10%? Neglect the effect of changes in the water surface levels in the reservoirs.

(c) Two mutually exclusive alternative water supply projects are given below: -

	Project A	Project B
	(Rs in Lakhs)	(Rs in Lakhs)
Construction Cost	350	250 1st stay 300 2nd stay
Annual Operation and Maintenance Cost	1.5	1.0 for 1st 10 years 2.0 for 2nd 10 years
Period of Analysis	20 years	20 years
Annual Benefits	25	30
Discount Rate	6%	6%

Which is the most economical project?

4+8+13=25

6.(a) With the help of a neat sketch, briefly explain an infiltration basin.

(b) An infiltration basin is to retain the first 2.5 cm of runoff from a 20 ha catchment. The area to be used for the infiltration basin is turfed, and the soil has a minimum infiltration rate of 100 mm/hr. If the retained runoff is to infiltrate within 36 hr, determine the surface area to be set aside for the basin.

(c) A 100m x 25m detention pond is proposed for a 7.5 ha site. The detention pond is 2.0 m deep under control (pre storm) conditions and the water quality depth is 2.0 cm. Storage in the detention pond is to be discharged offsite via a triangular weir which is at the control elevation, and the flow rate over the weir Q (m^3/s) is given by $Q=0.08\ H^{5/2}$, where H is the height of the

water surface above the vertex of the weir in m. Average annual rainfall at the site is 120 cm and the average runoff coefficient is 0.75. Determine the expression for evacuation time and the average detention time in the pond.

4+8+13=25

7.(a) Briefly explain design of stormwater management system.

(b) Briefly describe the selection criteria of a water quality control system.

(c) The estimated runoff hydrographs from a site before and after development are as follows:

Time (min)	0	30	60	90	120	150	180	210	240	270	300	330	360	390
Before (m^3/s)	0	1.2	1.7	2.8	1.4	1.2	1.1	0.91	0.74	0.61	0.50	0.28	0.17	0
After (m^3/s)	0	2.2	7.7	1.9	1.1	0.8	0.7	0.58	0.38	0.22	0.1	0	0	0

The post development detention basin is to be a detention pond drained by an outflow weir. The elevation versus storage in the detention pond is:

Elevation (m)	Storage (m)
0	0
0.5	5544
1.0	12,200
1.5	20,056

where the weir crest is at elevation 0 m, which is also the initial elevation of the water in the detention pond prior to runoff. The performance of the weir is given by $Q= 1.83\ bh^{3/2}$, where Q is the overflow rate (m^3/s), b is the crest length (m) and h is the head on the weir (m). Determine the required crest length of the weir for the detention pond to perform its desired function. What is the maximum water surface elevation expected in the detention pond?

(d) What is major drainage system?

4+3+15+3=25

8. (a) Briefly describe the different types of Multi Criteria Decision Making Methods.

(b) Compute Lp - metric values of alternatives and corresponding ranking pattern for the payoff matrix presented in below Table using Compromise Programming method for p = 1, 2. Assume equal weights for each criterion. Alternatives A_1 to A_6 in payoff matrix represent hydropower projects and criteria C_1 to C_6 correspond to manpower, Hydropower (MW), construction cost maintenance cost, number of villages to be evacuated and security level respectively. Assume necessary data.

Payoff matrix

Crit / Alt	C_1	C_2	C_3	C_4	C_5	C_6
A_1	80	90	6	5.4	8	5
A_2	65	58	2	9.7	1	1
A_3	83	60	4	7.2	4	7
A_4	40	80	10	7.5	7	10
A_5	52	72	6	2.0	3	8
A_6	94	96	7	3.6	5	6
Max/Min	Min	Max	Min	Min	Min	Max

4+21=25