Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem. 2019-20 | **Date**: 01.10.2019

Course Code: CIV 216 | **Time**: 1:00PM to 2:00PM

Course Name: HYDROLOGY AND WATER RESOURCES ENGINEERING | **Max Marks**: 40

Program & Sem: B.Tech, (CIV) & VII | **Weightage**: 20%

Instructions:

i. Question paper consists of 3 parts.
ii. Scientific and Non-programmable calculators are permitted.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries four marks. (3Qx4M=12M)

1. Define (C.O.NO.1) [Knowledge]
   a) Hydrology
   b) Precipitation
   c) Hyetograph
   d) Raingauge
2. List the forms of precipitation. (C.O.NO.1) [Knowledge]
3. Write the water budget equation for a catchment and expand its terms. (C.O.NO.1) [Knowledge]

Part B [Thought Provoking Questions]

Answer both the Questions. Each Question carries six marks. (2Qx6M=12M)

4. Symon's raingauge is the non-recording type of raingauge used in India. Describe the Symon's raingauge with a neat sketch. (C.O.NO.1) [Comprehension]

5. The rain gauge station D was in operative for a part of a month during storm occurred. The storm rainfall recorded at the three surrounding stations A, B, and C was 91.11, 72.23, and 79.89 cm respectively. If the average normal annual rainfall of the stations A, B, C, and D are 80.97, 67.59, 76.28 and 92.01 cm respectively. Estimate the storm rainfall at station D. (C.O.NO 1) [Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries eight marks. (2Qx8M=16M)

6. A catchment has six raingauge stations. In a year the annual rainfall recorded by the gauges are as follows:

Station	A	B	C	D	E	F
Rainfall (cm)	82.6	102.9	180.3	110.3	96.8	136.7

For a 10% error in the estimation of the mean rainfall. Calculate the optimum number of stations in the catchment. Also find the additional number of raingauges. (C.O.NO.1) [Comprehension]

7. Determine the average precipitation by arithmetic mean method and thiessen polygon method for the given data: (C.O.NO.1) [Comprehension]

Raingauge station	Area of thiessen polygon (km^2)	Precipitation (cm)
A	48	3.8
B	30	3.4
C	36	2.6
D	40	2.9
E	35	2.8
F	30	3.62

SCHOOL OF ENGINEERING

Semester: VII

Course Code: CIV 216

Course Name: Hydrology and Water Resources Engineering

Date: 01/10/2019

Time: 1 hour

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	C	
1	1	Module 1	1 1 1 1			4
2	1	Module 1	4			4
3	1	Module 1	4			4
4	1	Module 1		6		6
5	1	Module 1		6		6
6	1	Module 1			8	8
7	1	Module 1			8	8
	Total Marks					40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

[I hereby certify that All the questions are set as per the above guide lines .Bhavya N]

Reviewers' Comments

Annexure- II: Format of Answer Scheme

GAIN MORE KNOWLEDGE REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

SOLUTION

Semester: VII

Course Code: CIV 216

Course Name: Hydrology and Water Resources Engineering

Date: 01/10/2019

Time: 1 hour

Max Marks: 40

Weightage: 20%

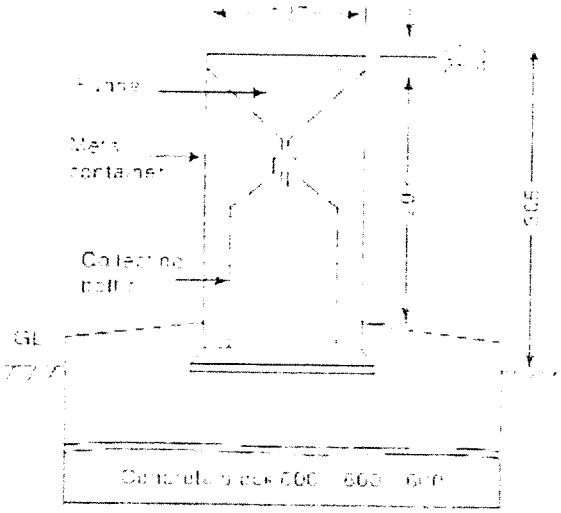
Part A (3Q x4 M =12 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	a) Hydrology: It is the science that deals with the occurrence, circulation and distribution of water of the earth and earth's atmosphere. b) Precipitation: Any form of water falling from the atmosphere to the earth. c) Hyetograph: A hyetograph is a plot of the intensity of rainfall against the time d) Rain gauge: A device used to measure the rainfall at a place.	4X1M=4	4 MINS

2	**a)** Drizzle **b)** Rain **c)** Snow **d)** Sleet **e)** Glaze **f)** Hail **g)** Mist **h)** Fog **i)** Dew **j)** Frost	**Any 8 forms** **8X1/2M= 4M**	**4 MINS**
3	The water budget of a catchment for a time interval Δt is written as: $P - R - G - E - T = \Delta S$ P = Precipitation, R = Surface runoff, G = net ground water flow out of the catchment, E = Evaporation, T = Transpiration, and ΔS = change in storage	**2 M for formula** **2**	**4 MINS**

Part B

(2Q x 6M = 12 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1		2 M 4X1M=4M	10 MINS

	1. Commonly used non recording type raingauge in India. 2. It essentially consists of a circular collecting area of 12.7 cm diameter connected to a funnel. 3. The rim of the collector is set in a horizontal plane at a height of 30.5cm above the ground level. 4. The funnel discharges the rainfall catch into a receiving vessel. 5. The funnel and receiving vessel are housed in a metallic container. 6. Water contained in the receiving vessel is measured by a suitably graduated measuring glass.		
2	The normal annual rainfall at missing station D, ND=92.01cm + or – 10% Range of normal value of ND ND +10% of ND=92.01+10%(92.01)=101.211cm ND-10% of ND=92.01-10%(92.01)=82.801cm The normal annual rainfall values at neighboring stations A,B and C are out of range of ND Hence adopt Normal Ratio Method $\frac{PD}{ND} = 1/m\left[\frac{PA}{NA} + \frac{PB}{NB} + \frac{PC}{NC}\right]$ $\frac{PD}{92.01} = 1/3\left[\frac{91.11}{80.97} + \frac{72.23}{67.59} + \frac{79.89}{76.28}\right]$ P_D=99.4cm	2 M 1 M 2 M 1 M	10 MINS

Part C (2Q x 8M = 16Marks)

Q No	Solution		Scheme of Marking	M re

Given m= 6,then

$$\bar{P} = \frac{(82.6 + 102.9 + 180.3 + 110.3 + 98.8 + 136.7)}{6} = 118.6\ cm$$ 1 M

$$\sigma_{m-1} = \sqrt{\frac{\sum_1^m (P_i - \bar{P})^2}{m-1}}$$ 2 M

$$\sigma_{m-1} = \sqrt{\frac{(82.6 - 118.6)^2 + (102.9 - 118.6)^2 + \ldots\ldots + (136.7 - 118.6)^2}{6-1}}$$

$$\sigma_{m-1} = 35.04\ cm$$

$$C_v = \frac{100 \times \sigma_{m-1}}{\bar{P}} = \frac{100 \times 35.04}{118.6} = 29.54\%$$ 2 M

$$N = \left(\frac{C_v}{\varepsilon}\right)^2 = \left(\frac{29.54}{10}\right)^2 = 8.7 \approx 9$$ 2 M

Additional raingauges required = 9-6 = 3 1M

2 Arithemetic mean method:

$$\bar{P} = \frac{(P1 + P2 + P3 + P4 + P5 + P6)}{m}$$ 2 M

$$\bar{P} = \frac{(3.8 + 3.4 + 2.6 + 2.9 + 2.8 + 3.62)}{6}$$ 1 M

$$\bar{P} = 3.18cm$$ 1 M

Thiessen polygon method:

$$\bar{P} = \frac{(P1 \times A1 + P2 \times A2 + P3 \times A3 + P4 \times A4 + P5 \times A5 + P6 \times A6)}{(A1 + A2 + A3 + A4 + A5 + A6)}$$ 2 M

$$\bar{P} = \frac{(3.8 \times 48 + 3.4 \times 30 + 2.6 \times 36 + 2.9 \times 40 + 2.8 \times 35 + 3.62 \times 30)}{(48 + 30 + 36 + 40 + 35 + 30)}$$ 1 M

$$\bar{P} = 3.19\ cm$$ 1 M

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PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY: Odd Sem 2019-20 | **Date:** 19.11.2019

Course Code: CIV 216 | **Time:** 1.00 PM to 3.00 PM

Course Name: HYDROLOGY AND WATER RESOURCES ENGINEERING | **Max Marks:** 40

Program & Sem: B.Tech – 7th Semester | **Weightage:** 20%

Instructions:

(i) Read the question properly and answer accordingly.
(ii) Scientific and Non-programmable calculators are permitted.
(iii) Write appropriate units for Numericals.

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries three marks. (4Qx3M=12 M)

1. List the 6 hydrologic losses (abstractions). (C.O.NO.2)[Knowledge]
2. Define Pan- Coefficient and write is equation. (C.O.NO.2)[Knowledge]
3. Define Infiltration, Infiltration capacity, Soil and Soil Hydraulic Conductivity in one sentence (C.O.NO.2)[Knowledge]
4. Write the Horton's Infiltration equation and expand the variables in it. (C.O.NO.2)[Knowledge]

Part B [Thought Provoking Questions]

Answer both the Questions. Each question carries four marks. (2Qx4M=8M)

5. Explain briefly why evaporation and transpiration are combined into one term. (C.O.NO.2)[Comprehension]
6. How is ϕ- index different from W- Index. Use the help of equations to differentiate between the same. (C.O.NO.2)[Comprehension]

Part C [Problem Solving Questions]

Answer all the Questions. (3Q=20M)

7. A storm with 10cm precipitation produced a direct runoff of 5.8cm. The rainfall intensities for 8 hour duration for hourly duration were 0.4, 0.9, 1.5, 2.3, 1.8, 1.6, 1 and 0.5 cm/h. Estimate the suitable infiltration index of the storm and tabulate the raingall excess table. [6M](C.O.NO.2)[Comprehension]

8. Estimate the Potential Evapotranspiration of an area for the season November to February in which wheat is grown. The area is north India at a latitude of 30^0N with mean monthly temperature and percentage sunshine hours as below. Take crop coefficient as 0.65 for wheat.

Month	Nov	Dec	Jan	Feb
Temp in °C	16.5	13	11	14.5
Monthly Sunshine hours	7.19	7.14	7.30	7.03

[8M](C.O.NO.2)[Comprehension]

9. Calculate the suitable type of evaporation from a lake using the rainfall data observed from Class A Pan. Assume Pan Coefficient as 0.75.

Day	**Rainfall (mm)**	**Water Added (mm)**
1	6	8
2	0	12
3	16	-5
4	3	10
5	5	9

[6M](C.O.NO.2)[Comprehension]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: 7th
Course Code: CIV 216
Course Name: Hydrology and Water Resources Engineering

Date: 19/11/2019
Time: 1 Hour
Max Marks: 40
Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	C	
1	2	2	3	-	-	3
2	2	2	3	-	-	3
3	2	2	3	-	-	3
4	2	2	3		-	3
5	2	2	-	4	-	4
6	2	2	-	4	-	4
7	2	2	-		8	8
8	2	2	-		6	6
9	2	2	-		6	6
	Total Marks		**12**	**8**	**20**	**40**

SCHOOL OF ENGINEERING

SOLUTION

Semester: 7th

Course Code: CIV 216

Course Name: Hydrology and Water Resources Engineering

Date: 19/11/2019

Time: 1 Hour

Max Marks: 40

Weightage: 20%

Part A **(4Q x 3M = 12 Marks)**

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	Interception Evaporation Transpiration Depression Detention Infiltration	0.5 mark for each loss	2 Mins
2	Rate of reservoir evaporation to pan evaporation is called the pan coefficient. Pan coefficient = Actual evaporation from reservoir / Measured evaporation from pan	2 Marks for Definition 2 Marks for equation	3 Mins
3	Infiltration: process by which water enters the soil surface Infiltration capacity: maximum rate at which water can enter the soil Soil Hydraulic Conductivity: movement of water through soil (saturated and unsaturated flow) Soil Water: water held in soil pores	1 Mark for each definition	4 Mins
4	Hortons Infiltration Equation $f = f_c + (f_0 - f_c)\, e^{-kt}$ fo – initial infiltration capacity\ T – time since the start of rainfall K –constant depending upon type of soil and condition of vegetable cover. fc- Minimum infiltration capacity related to hydraulic conductivity of the soil.	2 Marks for formula 2 Marks for expanding the variables	3 Mins

Part B (2Q x 4M = 8Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
5	Evapotranspiration (ET) is the sum of water used by plants in a given area in transpiration and the water evaporated from the adjacent soil area. While transpiration takes place from the vegetation, the land area where these plants stand also lose moisture by evaporation of water from soil and water bodies. **As it is difficult to separate these two losses in cropped fields, in designating water use by crops evaporation and transpiration are combined into one term called Evapotranspiration (ET) or Consumptive Use (CU).**	2 Marks for difference. Bold face sentence carries 2 marks	6 Mins
6	The W – index can be derived from the observed rainfall and runoff data. It differs from the ϕ-index in that it excludes surface storage and retention. **ϕ- index = (P-R) /t** **W-index=(P-R-S)/t** where P=total storm precipitation (cm) R=total surface runoff (cm) S=depression and interception losses (cm) t=time period (in hours)	1 Mark for difference 1 Mark for each formula 1 Mark for Variables	6 Mins

Part C (20 Marks)

<table>
<tr><th>Q No</th><th>Solution</th><th>Scheme of Marking</th><th>Max. Time required for each Question</th></tr>
<tr><td>7</td><td>Total Infiltration = 10 – 5.8 = 4.2cm
ϕ = 4.2 / 8 = 0.525 cm/hr
Infiltration = (10 – 5.8 – 0.4 – 0.5) = 3.3cm
Modified ϕ = 3.3 / 6 = 0.55 cm/hr
Rainfall excess Table</td><td>1 Mark
1 Mark
1 Mark
1 Mark
2 Mark for table</td><td>10 Mins</td></tr>
<tr><td>8</td><td>Nov – T =61.7, f = 4.43, u = 2.87
Dec – T =55.4, f = 3.95, u = 2.56
Jan – T =51.8, f = 3.78, u = 2.45
Feb – T =58.1, f = 4.08, u = 2.65</td><td>2 Marks
2 Marks
2 Marks
2 Marks</td><td>8 Mins</td></tr>
<tr><td>9</td><td><table><tr><th>Day</th><th>Evaporation Loss</th><th>Lake Evaporation</th></tr><tr><td>1</td><td>14</td><td>10.5</td></tr><tr><td>2</td><td>12</td><td>9</td></tr><tr><td>3</td><td>11</td><td>8.25</td></tr><tr><td>4</td><td>13</td><td>9.75</td></tr><tr><td>5</td><td>14</td><td>10.50</td></tr></table></td><td>1 Mark for Pan coefficient formula
0.5 mark for Evaporation Loss and Lake Evaporation calculation for each day respectively</td><td>10 Mins</td></tr>
</table>

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SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20 | **Date**: 28 December 2019

Course Code: CIV 216 | **Time**: 9:30 AM to 12:30 PM

Course Name: HYDROLOGY AND WATER RESOURCES ENGINEERING | **Max Marks**: 80

Program & Sem: B.Tech (CIV) & VII | **Weightage**: 40%

Instructions:

(i) Read the all questions carefully and answer accordingly.

(ii) All the questions have to be answered

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 2 marks. **(10Qx2M=20M)**

1.

i. What are the three different types of canals based on alignment? (C.O.No.4) [Knowledge]

ii. Differentiate between Actual Evapotranspiration and Potential evapotranspiration. (C.O.No.2) [Knowledge]

iii. List the different types of precipitation? (C.O.No.1) [Knowledge]

iv. List the various components of diversion headworks. (C.O.No.4) [Knowledge]

v. Define unit hydrograph. (C.O.No.3) [Knowledge]

vi. List the various flood control methods. (C.O.No.3) [Knowledge]

vii. List any four factors affecting runoff. (C.O.No.3) [Knowledge]

viii. What are the different factors affecting evaporation? (C.O.No.2) [Knowledge]

ix. List the various raingauges used for measuring rainfall. (C.O.No.1) [Knowledge]

x. Name the method of irrigation that will be used for easily erodible soills. (C.O.No.4) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 5 marks. **(4Qx5M=20M)**

2. Define flood routing, attenuation and lag time. What are different types of flood routing? (C.O.No.3) [Comprehension]

3. Define duty, delta and base period. The duty for a crop is 432 hectares/cumecs, when base period of the crop is 100 days. Determine the delta of the crop. (C.O.No.4) [Comprehension]

4. Explain water logging and suggest various methods to control waterlogging (C.O.No.4) [Comprehension]

5. Define hydrograph, hyetograph and mass curve. Explain the different components of hydrograph. (C.O.No.3) [Comprehension]

Part C [Problem Solving Questions]

Answer all the Questions. Each Question carries 8 marks. (5Qx8M=40M)

6. A 6 hour storm produced rainfall intensities 7, 18, 25, 12 10 and 3mm/hr in successive one hour intervals over a basin of 800 sq km. the resulting runoff is observed to be 2640ha-m. Determine phi index for the basin. (C.O.No.2) [Application]

7. The ordinates of a 2 hour unit hydrograph for a catchment are given as following. Find the ordinates of 4-hour unit hydrograph. (C.O.No.3) [Application]

Time(hours)	Discharge(m^3/sec)
0	0
2	10
4	15
6	25
8	10
10	0

8. A water course has gross command area of 5200ha out of which 80% is culturable. The intensity of irrigation for two crops rice and wheat are 20% and 40% respectively. The duty for these crops at the head of the watercourse are 800ha/cumec and 1800ha/cumec respectively. Find the discharge required at the head of the watercourse if the peak demand is 120% of the average requirement. (C.O.No.4) [Application]

9. A lake has a plan area of 100hectare. The water level in the lake is observed to decline by 20cm in month of February 2016. During this period the lake receives an inflow of 15 ha-m and outflow of 25ha-m occurs from the lake. The pan evaporation is recorded as 12cm from Class A plan and rainfall recorded is 3cm respectively. Find out the seepage loss from the lake in this month? (C.O.No.1) [Application]

10. A one hour unit hydrograph is triangular in shape with peak discharge of 50m3/sec at 10 hours and time base is of 30 hours. Find out the area of catchment. If rainfall of 5cm occurs in one hour and phi- index is 5mm/hr, find the peak discharge due to this storm. (C.O.No.3) [Application]

Format of Answer Scheme

SCHOOL OF ENGINEERING

SOLUTION

Semester: Odd Sem. 2019-20
Course Code: CIV 216
Course Name: HWRE
Program & Sem: B.Tech Civil 7th Semester

Date: 28.12.2019
Time: 3 HRS
Max Marks: 80
Weightage: 40%

Part A (10Q x 2M = 20Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1 i	Watershed/Ridge canal Side slope canal Contour canal	2	2min
Ii	**PET**- It is defined as the evapotranspiration from a large vegetation covered land surface with adequate moisture availability at all times. **AET-** The evapotranspiration actually occurring in a specific situation is called AET	2	2min
Iii	Convective precipitation Cyclonic precipitation Frontal precipitation Orographic precipitation	2	2min
Iv	Any 4 of them a) Weir b) Divide wall c)Fish ladder d)Approach channel e) Under sluice/ scouring sluices f) River training works/Marginal bunds g)Head regulators	2	2min
V	Unit hydrograph is a direct runoff hydrograph resulting from one unit (one inch or one cm) of constant intensity uniform rainfall occurring over the entire watershed.	2	2min
Vi	1. Structural measures: • Storage and detention reservoirs • Levees (flood embankments) • Flood ways (new channels) • Channel improvement • Watershed management 2. Non-structural methods: • Flood plain zoning •Flood forecast/warning • Evacuation and relocation • Flood insurance	2	2min
Vii	Any 4 of them: Drainage density Slope of catchment	2	2min

	Rainfall duration and intensity Land use land cover Stream order Urbanization Shape of catchment		
Viii	Factors affecting Evaporation 1. Vapour pressure difference 2. Temperature of air and water. 3. Wind Velocity: 4. Quality of water. 5. Atmospheric pressure and Altitude 6. Depth of water body	2	2min
Ix	Recording raingauge- Tipping bucket, weighing balance, natural syphon type Non recording - Symon	2	2min
X	Sprinkler and drip irrigation	2	2min

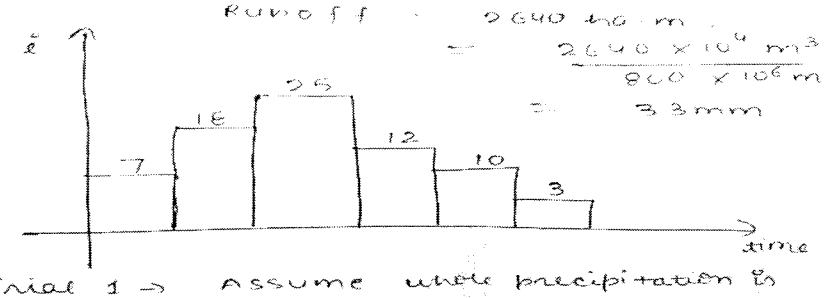
Part B (4Q x 5M = 20 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
2	Flood routing is the technique of determining the flood hydrograph at a section of a river by utilizing the data of flood flow at one or more upstream sections. Attenuation: The peak of the outflow hydrograph will be smaller than that of in-flow hydrograph. This reduction of peak as the wave pass through a reservoir or channel is known as attenuation. Time lag: The peak of the outflow occurs after the peak of inflow; the time difference between the two peaks is known as time lag. two broad categories of routing can be recognized. These are: 1. Reservoir routing, and 2. Channel routing.	1+1.5+1.5+1	15min
3	The depth of water required by the plant for its full growth is delta The area of land that can be irrigated by one cumecs of water is called duty. Hectares/cumecs The time taken from first watering to last watering is called base period. Time of irrigation is base period in days. Delta = 8.64* base period / duty Delta = 8.64* 100/ 432= 2metres	2+3	15min
4	An agricultural land is said to be water logged when the soil pores within the root zone of the crops are saturated to such an extent that normal circulation of air within the soil pores is totally cutoff. Effects of water logging: any 3 a) Absence of aeration in root zone of the plants	1+2+2	15min

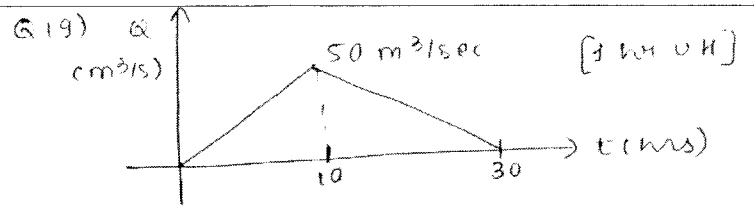
	b) Difficulty in cultivation operations c) Growth of weeds and aquatic plants d) Rise of salts in surface layers e) Leaching losses f) Restricted root growth g) Lower soil temperature: Microbe and , mosquito breeding h) Dampness causes plant diseases. Prevention- a)Reducing percolation from irrigation canals, water courses and fields b) Encouraging economical use of water c) Increasing outflow from the groundwater reservoir		
5	Discharge versus time plot is called hydrograph Intensity of rainfall versus time is called hyetograph Accumulated rainfall versus time is called mass curve. Components of hydrograph Rising limb- depends on rainfall and catchment Recession limb- depends on catchment characterstics Crest segment- carries the peak discharge.	1+1+1+2	15min

Part C (5Q x 8M = 40Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question

6	Q (5) d = 6 hrs Total rainfall = (7 + 18 + 25 + 12 + 10 + 3) = 75 cmm Area of basin = 800 sq km Runoff = 2640 ha-m $= \frac{2640 \times 10^4\ m^3}{800 \times 10^6\ m^2}$ = 3.3 mm  Trial 1 → Assume whole precipitation is contributing to runoff. $\phi_1 = \frac{P-R}{te}$ $= \frac{75-33}{6} = \frac{42}{6} = 7$ mm/h But 1st & 6th hour rainfall is not contributing to runoff $P_e = 75 - 7 - 3 = 65$ $\phi_2 = \frac{65-33}{4} = \frac{32}{4} = 8$ mm/h. all the rainfall intensities are above it, So, $\phi = 8$ mm/h.	8 1 Mark for formula Each step carries equal marks Final answer 1 mark	20min
7	Q (6) time: 0, 2, 4, 6, 8, 10 2 hr UH: 0, 10, 15, 25, 10, 0 2 hr UH lagged by 2 hrs: 0, 10, 15, 25, 10, 0 4 hr DRH: 0, 10, 25, 40, 35, 10, 0 4 hr UH: 0, 5, 12.5, 20, 17.5, 5, 0 time: 0, 2, 4, 6, 8, 10, 12 4 hr UH: 0, 5, 12.5, 20, 17.5, 5, 0	8 1 Mark for formula Each step carries equal marks Final answer 1 mark	20min

8	17) Gr C A = 5200 ha C C A = 0.80 × 5200 = 4160 ha Area under rice $\frac{20}{100} \times 0.8 \times 5200 = 832$ ha area under wheat $= \frac{40}{100} \times 0.8 \times 5200 = 1664$ ha Duty for rice = 800 ha / cumec discharge reqd $= \frac{832}{800} = 1.04 \, m^3/s$ duty for wheat = 1800 ha / cumec discharge reqd $= \frac{1664}{1800} = 0.924 \, m^3/s$ Design discharge = 1.04 m^3/s Peak demand = 120 % of design $= \frac{120}{100} \times 1.04$ = 1.248 m^3/sec	8 1 Mark for formula Each step carries equal marks Final answer 1 mark	20min
9	Q18) Area = 100 ha ΔS = - 20 cm. I = 15 ha-m Q. = 25 ha-m E_p = 12 cm class A $\bar{P}$ = 3 cm. seepage loss. =)) $(P + I) - (Q + E) - S = \Delta S$ $(3 + \frac{15}{100} \times 100) - (\frac{25}{100} \times 12 \times 0.7) - S = -20$ $18 - (25 + 8.4 - S) = -20$ $38 = 25 + 8.4 - S$ $S = 38 - (33.4)$ = 21.6 cm seepage loss $= \frac{4.6}{100} \times 100$ = 4.6 ha-metres.	8 1 Mark for formula Each step carries equal marks Final answer 1 mark	20min

10	(Q19)  area of catchment × depth of runoff = volume of runoff $A \times \left(\frac{1\,cm}{100}\right) m = \frac{1}{2} \times 50 \times 30 \times 3600$ $A = \frac{1}{2} \times 50 \times 30 \times 3600 \times 100$ $= 270 \times 10^6\ m^2$ $= 270\ km^2$ Rainfall = 5 cm. ϕ - index = 5 mm/hr Infiltration = 5 × 1 = 5 mm Runoff = 5 − 0.5 = 4.5 cm. discharge due to 1cm runoff = 50 m³/s Peak discharge due to 4.5 cm runoff = 50 × 4.5 = 225 m³/s	8 1 Mark for formula Each step carries equal marks Final answer 1 mark	20min