04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Engineering Hydrology *(CE606)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All questions**.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain double mass curve method for checking a rainfall data for consistency. [6]

   b) What factors should be considered in selecting a site for stream gauging station. [4]

   c) The catchment area of a reservoir is 1600 ha. A uniform precipitation of 8 mm/hr for 2 hour was observed on particular day. 55% run off reached the reservoir. A canal carrying a flow of $1 m^3/s$ is taken from the reservoir. The rate of evaporation was 0.8 $mm/h/m^2$. Assuming seepage loss is 40% of evaporation loss, find the change in the reservoir level for 6 hours, if the water spread of the reservoir was 45ha. [6]

2. a) Explain the different methods of determining the average rainfall over a catchment due to a storm. [6]

   b) Calculate the potential evapotranspiration from an area near Dharan, Sunsari in the month of april by Penmans' formula. The following data are available. [10]

   Latitude: 26°-49'N, Elevation (from msl) : 250.00 m
   Mean monthly temperature : 22.5°C, Mean relative humidity: 75%
   Mean observed sunshine hour: 10 hr Wind velocity at 2m height: 80 km/day
   Psychrometric constant : 0.49mm of Hg/°C Reflection coefficient:0.20
   e_w : 20.4mm of Hg, A: 1.24mm/°C b = 0.52, H_a = 14.9mm of evaporable water per day
   Mean monthly value of possible sunshine hour (N) : 12.7 hours
   Nature of sunshine cover: closed ground green crop, where the symbols carry their usual meanings

3. a) The mass curve of an isolated storm over a watershed is given below.

Time from start (hr)	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Cumulative rainfall (cm)	0	0.6	1.4	1.9	2.8	3.7	5.4	6.2	7	7.8	8.2

   If the storm produced a direct run off of 3.8 cm at the outlet of the watershed, estimate the Ø-index of the storm and duration of rainfall excess. [6]

   b) The ordinates of a 2-h UH are given below. Derive the ordinates of a 3-h UH by S-curve method.

Time (hr)	0	2	4	6	8	10	12	14	16	18	20	22	24
Ordinates of 2-h UH (m^3/s)	0	25	100	160	190	170	110	70	30	20	15	6	0

   Calculate the flood discharge of a storm of 3h and 2h rainfall of 8 cm and 7 cm respectively. Consider Ø-index 0.3cm/hr and baseflow $10 m^3/s$. [10]

4. a) The ordinates of 4 hr unit hydrograph are given below.

Time (hr)	0	2	4	6	8	10	12	14	16	18	20	22	24
4-hr UH ordinates (m^3/s)	0	9	12	28	40	52	49	36	29	20	13	10	0

The storm has successive 2 hr, 4 hr and 6 hr rainfall of 2.5, 8.0 and 9.0 cm respectively. ϕ-index is of 0.15 cm/hr and base flow of $40m^3/s$. Determine the 2 hr UH and resulting flood hydrograph from above storm. [12]

b) Annual flood peak flood of a river for 20 years yielded a mean value of 5460 m3/s and the standard deviation of 2950 m^3/s, The proposed hydraulic project on this river has an expected life of 35 years and reliability of project is 87%.

(i) Using Gumbel's method predict the flood discharge for the project if the value of $\bar{y}n = 0.5402$ and $Sn = 1.1285$.

(ii) What discharge is to be adopted if the safety factor for flood magnitude is taken as 1.5 and also determine safety margin on this basis.

(iii)Calculate the confidence limits at 95% confidence probability f(c) = 1.96 [12]

5. Route the following hydrograph through a river reach for which K = 12h and X = 0.20. At the start of the inflow flood, the outflow discharge is $10m^3/s$ also find lag of peak and lag attenuation. [10]

Time (h)	0	6	12	18	24	30	36	42	48	54
Inflow (m^3/s)	10	20	50	60	55	45	35	27	20	15

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2074 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Engineering Hydrology *(CE606)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Explain water budget equation. What is the role of water budget equation in hydrology? [2+2]
2. The annual rainfall at station X and the average of annual rainfall at 25 surrounding base stations in can are given below for the period of 36 years starting from 1941 [6+1+4+3]
   i) Check whether the data of starting X is consistent
   ii) In which year a change in regime indicated?
   iii) Compute the mean annual rainfall for stations X at its present site for the given 36 year period first without adjustment and secondly with the data adjusted for the change in regime.
   iv) Compute the adjusted annual rainfall at station X for the affected period.
3. a) Starting from Horton's equation, derive an expression for total infiltration in time "t". Also draw graph showing infiltration and total infiltration vs time. [4+2]
   b) Calculate the potential evapotranspiration from an area near Simara, Bara, in the month of April by Penman's formula. The following data are available. [10]

   Latitude: 27'N

   Elevation (from msl): 107 m

   Mean monthly temperature: 23°C

   Mean relative humidity: 75%

   Mean observed sunshine hour: 10

   Wind velocity at 2 m height: 85 km/day

   Nature of sunshine cover: closed ground green crop

   Given:

   A: 1.27mm/°C

   H_a = 15.00 mm of evaporable water per day

   Mean monthly value of possible sunshine hour (N): 12.5 hours

   Saturated vapour pressure at 23°C = 21.04 mm of Hg

4. a) Calculate the flood discharge of a stream by the slope area method given the following data: [12]

Upstream flow area = 3500 m^2

Upstream wetted perimeter = 650

Upstream velocity head coefficient = 1.17

Down stream flow area = 3250 m^2

Down stream wetted perimeter = 621 m

Down stream velocity head coefficient = 1.21

Falling difference = 0.4

Reach length = 1300 m

Manning's coefficient η = 0.03

b) Describe about the use of current meter according to flow characteristics of channel. [4]

5. a) What is Unit hydrograph? What are assumptions and limitations of UH? [2+2]

b) In a storm, the rainfall of depth 0.7cm, 0.9cm, 0.2cm, 1.0cm occurred in four successive hours. The storm hydrograph due to this storm has following hourly ordinates: [8]

0.5, 44.5, 110.5, 85.5, 102.8, 94.0, 38.4, 18.6, 10.9, 5.3, 2.9, 0.5 m^3/s

If the average losses are 0.2cm/hr, estimate the hourly ordinates of unit hydrograph. Assume suitable value of base flow. Calculate 2-h UH using Scurre Method.

6. A river, whose annual flood peak can be represented by Gumbel distribution, has 100-years and 500-year return period flood of magnitude 9900 m^3/s and 12100 m^3/s respectively. The sample size is n = 30. $\left[\bar{y}_n = 0.536,\ s_n = 1.1124\right]$ [4+4+3+3]

i) What is the magnitude of 200 year and 1000 year flood?

ii) What are 95% and 80% confidence limits for 200 year and 1000 year flood if f (95%) = 1.96 and f (80%) = 1.28

iii) A hydraulic structure of 25 year life was designed for 12300 m^3/s peak flow. What is the hydrologic risk of the structure?

iv) What peak flow should be taken into consideration if you want the structure to be 99% reliable for a structure life of 25 years.

7 A drainage basin has the following Characteristics. [4]

Area = 172 Km^2,

Storage constant = 10 hour

Time of concentration = 8 hour

The inner-isochrones area distributions are as follows

Travel Time (hr)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
Inter-isochrones area (Km^2)	12	40	26	36	28	18	8	4

Determine the IUH for this catchment.

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Year	Rainfall at X	Average rainfall of base stations	Year	Rainfall at X	Average rainfall of base station
1941	163	135	1959	112	123
1942	119	111	1960	95	142
1943	121	124	1961	106	92
1944	129	111	1962	81	91
1945	126	123	1963	116	131
1946	120	90	1964	112	104
1947	153	138	1965	80	97
1948	172	119	1966	88	111
1949	127	108	1967	85	114
1950	108	107	1968	90	92
1951	126	111	1969	120	146
1952	190	142	1970	72	93
1953	112	112	1971	113	138
1954	97	99	1972	82	112
1955	86	93	1973	116	117
1956	111	131	1974	122	152
1957	68	92	1975	73	90
1958	88	142	1976	74	104

03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Engineering Hydrology *(CE606)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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- ✓ *Assume suitable data if necessary.*

1. Explain Water balance Equation and explain each process. [4]
2. A storm commenced at 7:00 hours. The ordinates of the rainfall mass curve of this storm in mm as recorded by a recording rain gauge at 15 minute intervals are 0, 9.5, 17.0, 27.0, 40.5, 49.0, 63.0, 84.0, 95.0, 102.0, 110.0, 112.0 and 112.0. Plot the intensity duration graph by computing the maximum rainfall intensities for durations of 15, 30, 45, 60, 90, 120 and 180 minutes. [12]
3. a) Explain energy balance equation and derive evaporation equation using Bowen's ratio. [4]

   b) For a storm of 3 hours on 50 ha catchment, the rainfall rates are as follows: [6]

Time of rain from beginning (min):	0	30	45	75	100	125	150	180
Rain fall rate (cm/hour):	0	2.5	3.5	2.0	4.8	5.2	1.8	5.3

   If the ϕ index of this basin is 2.5 cm/hour, calculate total rainfall, runoff in (cm) and peal discharge.

   c) Explain interception and depression storage losses. How these losses are estimated during hydrological analysis. [2+2]
4. a) Explain how stage discharge relationship is established. [4]

   b) Explain the procedure of stream flow measurement by area-velocity method. Also, describe the mid section method for discharge computation using sketch and equations. [3+3]

   b) What factors should be considered in selecting a site for stream gauging station. [4]
5. a) The 3 h unit hydrograph of a basin with an area of 20 km^2 at one hour interval are as given below 0, 0.41, 1.38, 4, 7.72, 10.06, 9.24, 6.62, 4.57, 3.86, 2.76, 2.07, 1.38, 0.83, 0.41, 0. If rainfall excess with intensity of 2.0 cm/h for a period of 4 h followed immediately by another 3 h storm with an intensity of 1 cm/h occurs on the basin, what is the peak flow produced by this rainfall and at what time after the commencement of rainfall would this peak flow occur? Assume baseflow is negligible. [10]

   b) A 6 h unit hydrograph of a basin has a peak ordinate of 96 m^3/s. When the base flow in the stream is 25 m^3/s, and when the basin has reached its minimum infiltration capacity of 2.5 mm/h, a 6 h storm with 18.3 cm of total rainfall had occurred on the basin. What is the magnitude of the peak discharge in the flood hydrograph produced by this storm? [4]

6. a) The annual peak discharge of a river follows the Gumbel's extreme value distribution with a mean of 10000 m^3/s and a standard deviation of 3000 m^3/s. What is the probability that the annual peak discharge is more than 15000 m^3/s? What is the magnitude of the peak discharge with an exceedance probability of 0.1? [Hint: $\alpha = \frac{1.28255}{\sigma}; \beta = \mu - 0.48\sigma$] [8]

b) Differentiate between continuous and discrete random variables. Give examples each in hydrology. Give three formulae which are used to determine the return period. [1+2+3]

7. The ordinates of the inflow hydrograph at 6 hr interval are as follows: [8]

Time (hrs)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
Discharge (m^3/s)	0	50	280	610	1290	1900	2130	1900	1600	1440	1060	780	500	370	220	130

The discharge over the spillway Crest and the surcharge storage above the crest for different water surface elevations are as follows:

Water surface elevation (m)	140	141	142	143	144	145	146
Outflow Discharge (m^3/s)	0	170	482	883	1360	1905	2500
Storage $\times 10^6 (m^3)$	0.00	15.0	35.0	60.0	95.0	140.0	240.0

Determine:

i) Maximum reservoir level
ii) Maximum outflow rate
iii) Reduction in the peak

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04 TRIBHUVAN UNIVERSITY
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Examination Control Division
2072 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Engineering Hydrology *(CE606)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. Define the following terms: hydrological cycle, runoff, water balance and catchment. [4]

2. The catchment area of a basin may be approximated as a semicircle of radius r km with respect to the corordinate axis set up with its origin at the center of the circle and the x-axis coincident with the diameter the area lies in the first and second quadrants and the position coordinates of the rain gauge stations are (0,0), $\left(\frac{r}{2},\frac{r}{2}\right)$ and $\left(\frac{-r}{2},\frac{r}{2}\right)$ km. Show that the Thiessen weights of the gauges are given by $\frac{0.5}{\pi}$, (0.5-0.25/π) and (0.5-0.25/π) respectively. [12]

3. a) The ordinates of a rainfall mass curve of a storm over a basin of area 850 km^2 measured in mm at one hour interval are 0, 10, 22, 30, 39, 45.5, 50, 55.5, 60, 64 and 68. If the infiltration during this storm can be represented by Horton's equation with f_o = 6.5 mm/h, f_C = 1.5 mm/h and k = 0.15 /h, estimate the resulting runoff volume. [10]
   b) Write down Penman equation and explain all variables and constants involved in it. [4]

4. a) Mention the factors that should be considered for the proper selection of stream ganging site. [4]
   b) Explain with sketch how you determine the stage for zero discharge. [6]
   c) Find the drainage density, average length of overland flow, form factor and channel slope for a basin with the following data: [4]

   Area of basin (A) = 140 km^2
   Distance between the outlet to the farthest point (L) = 21 km
   Elevation difference between the outlet and the farthest point (h) = 1090 m
   Total length of channels of all order (L_s) = 654 km

5. a) Describe the procedure of derivation of unit hydrograph from complex storms using appropriate expressions. [8]
   b) Given below are ordinates of a 4 h unit hydrograph of a basin in m^3/s at one hour intervals. [6]

   4, 25, 44, 60, 70, 61, 52, 45, 38, 32, 27, 22, 18, 14, 11, 8, 6, 4, 2, 1

   What is the area of the basin?

6. The observed annual peak flood of a river in m^3/s for a period of 20 years from 1981 to 2000 are given below: [14]
   190, 155, 298, 136, 137, 131, 140, 124, 185, 104, 91, 154, 109, 269, 164, 270, 142, 72, 130, 111.
   Prepare a graph of flood peak versus the return period and hence estimate the annual peak flood with a return period of 30 years.

7. Route the following flood hydrograph through a river reach for which Muskingum coefficient k=10 h and x=0.2. At the start of inflow flood, the outflow discharge is 10 m^3/sec. [8]

Time (h)	0	6	12	18	24	30	36	42	48	54

04 TRIBHUVAN UNIVERSITY
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Year / Part	III / I	Time	3 hrs.

Subject: - Engineering Hydrology *(CE606)*

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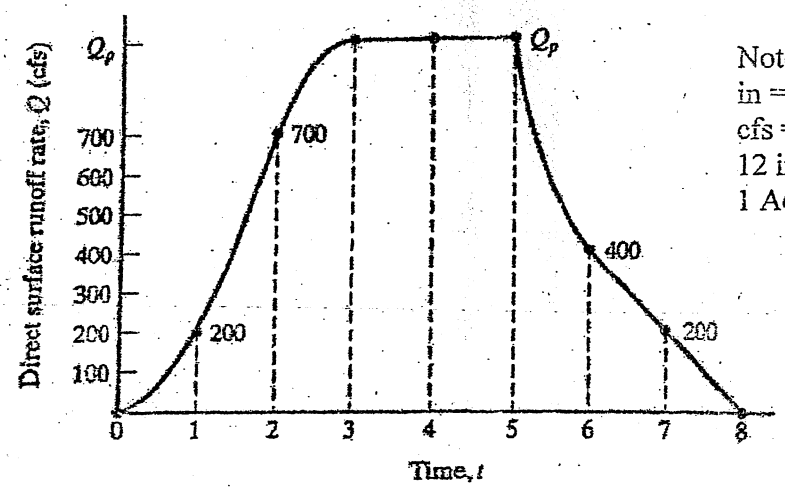
1. Explain Hydrologic cycle and water balance equations. [2+2]
2. a) Explain the different methods of determining the average rainfall over a catchment due to a storm. Discuss the relative merits and demerits of the various methods. [3+3]
   b) Explain double mass curve test for rainfall data. [6]
3. a) Explain briefly (i) Infiltration Capacity (ii) Φ-index lake (iii) W-index [6]
   b) Explain the energy budget method of estimating evaporation from a lake. [8]
4. a) Determine the stage corresponding to zero discharge from the following data of a rating curve: [8]

Stage (m)	20.80	21.42	21.95	22.37	23.00	23.52	24.00
Discharge(m^3/s)	100	200	300	400	600	800	1000

   b) Explain different methods of Stream gauge reading with sketch. [6]
5. A hydrograph for a 4,250-acre basin is shown in the accompanying sketch. The given hydrograph actually appeared as a direct runoff hydrograph from the basin, caused by net rain falling at an intensity of 0.20 in./hr for a duration of 5 hr, beginning at t =0. [4+3+3+4]



Note
in = inches
cfs = cubic feet/sec
12 inches = 1 foot
1 Acre = 43560 sq.ft

(a) Determine the excess release time of the basin.

(b) What percentage of the drainage basin was contributing to direct runoff 4 hr after rain began ($t = 4$)?

(c) Use your response to part (b) to determine Q_p, as shown in the sketch. Do not scale Q_p from the drawing.

(d) Note that rain continued to fall between $t = 3$ and $t = 5$. Why did the hydrograph form a plateau between $t = 3$ and $t = 5$, rather than continue to rise during those 2 hours?

6. a) Explain Gumble's Distribution function. Derive frequency factor (k) using Gumble's distribution. [7]

   b) The flood discharge for 25 and 250 years from fitted Gumbel distribution are 90 and 550 m^3/sec respectively. Estimate the flood magnitudes for 50, 500 and 1000 years by Gumbel analytically. [7]

7. A basin having 128 km^2 of drainage area has 22 hours and 14 hours of concentration time and storage constant respectively. Determine the IUH for this basin if inter-isochrones area distribution is as below: [8]

Travel time (hr)	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27
Area(km^2)	2	7	17	25	31	23	14	6	3

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04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Engineering Hydrology *(CE606)*

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- ✓ *Attempt **All** questions.*
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1. Explain all hydrological process in Hydrological Cycle. [4]
2. a) Describe methods of averaging point rainfall over a catchment area with neat sketches. [6]
   b) Explain the energy budget method of estimating evaporation from a lake. [6]
3. Calculate the potential evapotranspiration for an area over Kathmandu in the month of March by Penman Method. [14]

The flowing data is available:

Mean Monthly temp	: 10.0°C
Mean RH	: 60%
Mean sunshine hours	: 9 h
Potential sunshine hours	: 12.9 h
Wind Velocity at 2m height	: 5 Km/hour
Albedo	: 0.25

Upper terresterial Solar radiation = 11 mm of hg/day

Other values:

Latitude	: 28.5°
Longitude	: 84.5°
Saturated vapor pressure at 10.0 °C	= 9.2 mm of Hg
Slope of saturate vapor pressure	= 1.24 mm/°C
Psychrometric constant	= 0.49mm/°C
Boltzman constant	= 2.01*E-9 mm/day

4. a) Compute the stream flow from following data. The calibrated equation of current meter is: [8]

V=0.035+0.74*N, where V is in m/sec and N is revolution/sec.

Distance from bank (m)	0	0.6	1.5	2.5	3.5	5.0	6.0	7.0	7.5
Water Depth (m)	0	0.3	0.75	1.2	1.7	1.3	0.7	0.3	0
No. of Revolutions	0	15	95	110	120	110	80	20	0
Time (sec)	0	45	85	95	90	100	70	40	0

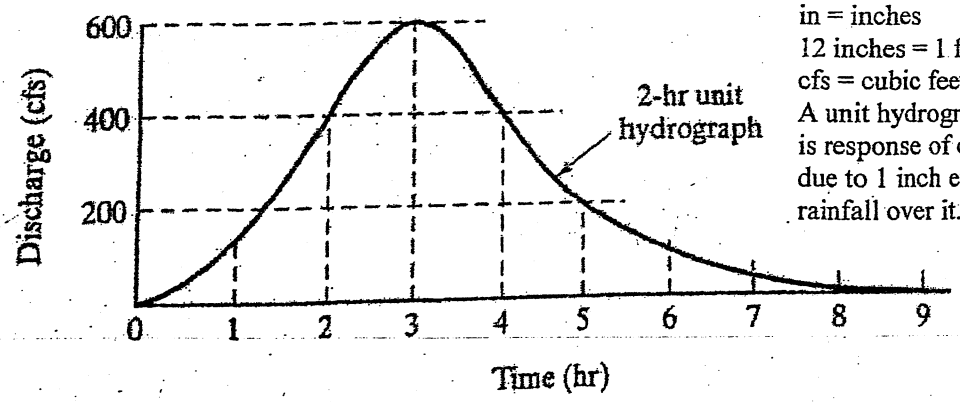
   b) Explain how the monthly flows from the ungauged locations are estimated from the observed rainfall data over the catchment, in Nepal. [6]

5. A 2-hr unit hydrograph for a basin is shown in the sketch. [6+3+5]

(a) Determine the peak discharge (in cfs) for a net rain of 5.00 in./hr and a duration of 2 hr.

(b) What is the total direct surface runoff (in inches) for the storm described in part (a)?

(c) A different storm with a net rain of 0.50 in./hr lasts for 4 hr. What is the discharge at 8 p.m. if the rainfall started at 4 p.m.?



Note:
in = inches
12 inches = 1 feet
cfs = cubic feet/sec
A unit hydrograph is response of catchment due to 1 inch effective rainfall over it.

6. a) If the annual flood series data for a catchment are available for N consecutive years, explain a procedure to determine a flood discharge with a return period of T, (where T>N), by using Log Pearson type III distribution method. [8]

b) Calculate the flood discharge using Empirical method from a catchment of area 100sqkm. The catchment has longest river of 60km. The elevation difference of the river is 20m. Rainfall runoff coefficient is 0.6 and maximum daily rainfall is 200mm. [6]

7. Explain in detail time area method for estimating runoff hydrograph. [8]

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Subject: - Engineering Hydrology *(CE606)*

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1. Define Hydrological cycle and water balance equation. Write down a general water balance equation for a basin. [4]

2. a) The shape of a catchment is in the form of a pentagon ABCDE. There are 4 rain gauge stations P,Q, R and S inside the catchment. The position co-ordinates in km are: A(0,0), B(50,75), C(100,70), D(150,0), E(75,-50), P(50,25), Q(100,25), R(100,-25) and S(50,-25). If rainfalls recorded at P,Q,R and S are 90, 105, 114 and 120 mm respectively, determine the mean rainfall by Thiessen Polygon method. [6]

   b) Explain the different types of precipitation based on lifting mechanism. [6]

3. a) Calculate the free water surface evaporation in june using the Penman method from an area, whose latitude is approximately 33°N. The available data include air temperature = 30°C, wind speed at 2 m height = 10 km/h, relative humidity = 60%, mean observed sun shine hours = 12 and reflection coefficient = 0.05. [8]

   b) The infiltration capacity in a basin is represented by Horton's equation as $fp = 3.0 + e^{-2t}$, where fp is in cm/hr and 't' in hours. Assuming the infiltration to take place at capacity rates in a strom of 60 minutes during, estimate the depth of infiltration in (i) the first 30 minutes and (ii) the second 30 minutes of the storm. [3+3]

4. a) Estimate the flood discharge through a 5m-wide rectangular channel for the following data. The depth of water is 2m and 1.8m at two section 500m apart. The drop in water surface elevation is 0.25 m. Manning's roughness coefficient is 0.025, Assume eddy loss to be zero. [8]

   b) The following data were collected for a stream at a gauging station. Compute the discharge. [6]

Distance from one end of water surface (m)	Depth, d (m)	Immersion of current meter below water surface					
		at 0.6d		at 0.2d		at 0.8d	
		Rev.	Sec.	Rev.	Sec.	Rev.	Sec.
3	1.4	12	50				
6	3.3			38	52	23	55
9	5.0			40	58	30	54
12	9.0			48	60	34	58
15	5.4			34	52	30	50
18	3.8			35	52	30	54
21	1.8	18	50				

Rating equation of current meter : v= 0.3N+0.05

5. An S- hydrograph is given such that at time t = 0, its ordinate is 1cm/h and it remains so for an indefinite period of time. Determine a 2-hour unit hydrograph. Using this unit hydrograph, determine a 4- hour unit hydrograph. [8+6]

6. An analysis of an annual flood., series convering the period 1890 to 1966 on a certain river shows that the 80 year flood has a magnitude of 620000 units and 1.4 year flood has a magnitude of 215000 units. Assume the annual floods are Gumbel distributed. [6+4+4]

   i) What is the probability of having a flood as great as or greater than 440000 units?

   ii) What is the magnitude of flood having a recurrence interval of 40 years?

   iii) What is the probability of having 575000 units flood or a greater flood in the coming 25 years time?

7. a) Explain the concept of attenuation and lag of peak due to routing with sketch. [4]

   b) Starting from the continuity equation, obtain the equation of reservoir routing. [4]

SATURATION VAPOR PRESSURE OF WATER

Temperature, °C	Temperature, °F	Saturation vapor pressure, e, mb	Saturation vapor pressure, e, mm of Hg	Slope (mm Hg/°F)
0	32	6.11	4.58	0.30
5.0	41.0	8.72	6.54	0.45
7.5	45.5	10.37	7.78	0.54
10.0	50.0	12.28	9.21	0.60
12.5	54.5	14.49	10.87	0.71
15.0	59.0	17.05	12.79	0.80
17.5	63.5	20.00	15.00	0.95
20.0	68.0	23.38	17.54	1.05
22.5	72.5	27.25	20.44	1.24
25.0	77.0	31.67	23.76	1.40
27.5	81.5	36.71	27.54	1.61
30.0	86.0	42.42	31.82	1.85
32.5	90.5	48.89	36.68	2.07
35.0	95.0	57.07	42.81	2.35
37.5	99.5	64.46	48.36	2.62
40.0	104.0	73.14	55.32	2.95
45.0	113.0	94.91	71.20	3.66

MEAN MONTHLY SOLAR RADIATION INCIDENT AT THE EARTH'S OUTER SPACE (EXTRATERRESTRIAL RADIATION), I_a IN MM OF EVAPORABLE WATER/DAY, IN NORTHERN HEMISPHERE WITH L = 560 CAL/G.

Month	North latitude (°N) 90°	80°	70°	60°	50°	40°	30°	20°	10°	0°
January	—	—	—	1.4	3.6	6.0	8.5	10.8	12.8	14.5
February	—	—	1.1	3.5	5.9	8.3	10.5	12.3	13.9	15.0
March	—	1.8	4.3	6.8	9.1	11.0	12.7	13.9	14.8	15.2
April	7.9	7.8	9.1	11.1	12.7	13.9	14.8	15.2	15.2	14.7
May	14.9	14.6	13.6	14.6	15.4	15.9	16.0	15.7	15.0	13.9
June	18.1	17.8	17.0	16.5	16.7	16.7	16.5	15.8	14.8	13.4
July	16.8	16.5	15.8	15.7	16.1	16.3	16.2	15.7	14.8	13.5
August	11.2	10.5	11.4	12.7	13.9	14.8	15.3	15.3	15.0	14.2
September	2.6	4.0	6.8	8.5	10.5	12.2	13.5	14.4	14.9	14.9
October	—	0.2	2.4	4.7	7.1	9.2	11.3	12.9	14.1	15.0
November	—	—	0.1	1.9	4.3	6.7	9.1	11.2	13.1	14.6
December	—	—	—	0.9	3.0	5.5	7.9	10.3	12.4	14.3

MEAN MONTHLY VALUES OF POSSIBLE SUNSHINE HOURS, N

Latitude (°N)	Month Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0°	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
10°	11.6	11.8	12.1	12.4	12.6	12.7	12.6	12.4	12.9	11.9	11.7	11.5
20°	11.1	11.5	12.0	12.6	13.1	13.3	13.2	12.8	12.3	11.7	11.2	10.9
30°	10.4	11.1	12.0	12.9	13.7	14.1	13.9	13.2	12.4	11.5	10.6	10.2
40°	9.6	10.7	11.9	13.2	14.4	15.0	14.7	13.8	12.5	11.2	10.0	9.4
50°	8.6	10.1	11.8	13.8	15.4	16.4	16.0	14.5	12.7	10.8	9.1	8.1

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03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Engineering Hydrology *(CE606)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Normal graph papers will be provided.*
- ✓ *Assume suitable data if necessary.*

1. Why the study of hydrology is important for engineers for planning and designing of water resources projects in Nepal? Explain the significant features of global water balance with necessary equation. [2+2]

2. a) In what way you can present the precipitation data? What are the benefits of each method? Explain the method of drawing Intensity Duration Frequency (IDF) curve. [3+2+3]

   b) A catchment has seven raingauge stations. In a year the annual rainfall in cm recorded by the gauges are as follows: 130, 142.1, 118.2, 108.5, 165.2, 102.1, 146.9 for a 5% error in the estimation of the mean rainfall, calculate the minimum number of additional stations required to be established in the catchment. [4]

3. A 4-hour storm occurs over a 80 km^2 watershed. The details of the catchment are as follows: [14]

Sub basin (km^2)	ϕ index (mm/h)	Hourly Rainfall (mm)			
		1st hour	2nd hour	3rd hour	4th hour
15	10	16	48	22	10
25	15	16	42	20	8
35	21	12	40	18	6
5	16	15	42	18	8

Calculate the runoff from the catchment and the hourly distribution of the effective rainfall for the whole catchment.

4. Calculate the discharge of river section as given: [14]

Distance (m)	0	1	2	3	4	6	8	12	16	17	18	19
Depth (m)	0	1	4.3	7.2	8.5	7.4	5.6	4.7	3.5	2.1	1.4	0
Revolution / s at 0.2d	0	1.4	1.0	2.6	2.9	2.7	2.5	2.3	2.1	1.8	1.5	0
Revolution / s at 0.8d	0	.7	1.2	1.8	2.0	1.9	1.7	1.5	1.3	1.1	1.0	0

The current meter formula is v = 0.02 Ns -0.02, v = velocity (m/s) and Ns = revolution per minute.

5. In a storm the rainfall excess of 0.5 cm, 0.0 cm and 0.8 cm occurred in three successive hours. The storm hydrograph due to this storm has the hourly ordinates (Q) as given below: 0.5, 44.5, 110.5, 85.5, 102.8, 94.0, 38.4, 18.6, 10.9, 5.3, 2.9, 0.8 (cumecs). If there is a constant base flow of 0.5 cumecs, find the hourly ordinates of unit hydrograph. If 2 successive storms of 6.5 cm and 10.5 cm of 3 hours duration and ϕ-index of 0.2 cm/hr occurred in the same catchment, what is the peak flow from the catchment? [9+5]

6. a) Mention the steps for the computation of flood of return period T using graphical method. [4]

b) The following are the annual peak flow data (m^3/s) of a river from 1990 to 2006: [10]

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
Peak discharge (m^3/s)	1400	4160	2580	2910	2250	1360	2280	2540	3900
Year	1999	2000	2001	2002	2003	2004	2005	2006	
Peak discharge (m^3/s)	3420	6170	2160	1360	5440	1340	3360	2800	

Compute flood magnitude with 50 year return period (T) using Log-Pearson type III distribution. For T = 50 year, obtain frequency factor (K_T) for the computed coefficient of skewness (C_s) using following table.

C_s	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
K_T	2.054	2.107	2.159	2.211	2.261	2.311	2.359	2.407	2.453	2.498	2.542

C_s	1.2	1.4	1.6	1.8	2	2.2	2.5	3
K_T	2.626	2.706	2.78	2.848	2.912	2.970	3.048	3.152

7. Explain the procedure of deriving Clark UH. [8]

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03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Engineering Hydrology *(CE606)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Explain different prospects of Hydrological study. [4]

2. a) What can be the causes of inconsistency while recording the rainfall of a station? Explain how it can be corrected for the future use? [4]
   b) The rainfall depth with time during a storm at a station is as given: [2+6]

Time	6:00	6:30	7:00	7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00
Rainfall (cm)	0	7	5	8	9	13	10	8	6	5	3	1	0

   i) Construct the hyetograph of this storm for 30 min and 2 hours interval
   ii) Compute maximum average intensity of rainfall for 30 min, 1 hour, 2 hour in this storm and plot the resulting intensity duration curve.

3. a) Calculate the daily potential evapotranspiration by the Penman method from an area having the following characteristics: latitude = 30°N, elevation = 300 m above mean sea level, mean monthly temperature = 15°C, mean relative humidity = 70%, mean observed sunshine hours = 10, wind velocity at 2 -m height = 50 km/day and reflection coefficient is 0.05. [8]

   b) Precipitation falls on a 100 km^2 drainage basin according to the following schedule: [6]

Time (minute)	30	60	90	120
Rainfall intensity (cm/hr)	4	2	6	5

   Determine the total storm rainfall. Also, find out ϕ-index for the basin if the net storm runoff is 3 cm.

4. a) Explain the stream flow computation by slope area method. [5]
   b) Write the method of estimating monthly flows in a stream or river by MIP method in a Nepalese river. [4]
   c) What is mean by rating curve? Write the uses of rating curve. Also explain the method of drawing the rating curve in a particular section of a river. [1+2+2]

5. a) The direct runoff hydrograph due to an effective rainfall event in given by a triangle such that its base is 8 hours and its height at the midpoint of the base is 1cm/h. The duration and intensity of the effective rainfall are 4 hours and 1cm/h, respectively. Derive and sketch a 4 hour unit hydrograph. [8]

   b) A 1 hour unit hydrograph is given by a rectangle whose base is 4 hours and height is 0.25/hour. Construct an S-hydrograph using this UH. [6]

6. a) Analysis of the annual flood peak of a river for 43 years yielded a mean of 330m^3/s and a standard deviation of 187 m^3/s. A proposed water control project on this river is to have an expected life of 50 years. Policy decision of the project allows an acceptable reliability of 85%. Using Gumbel's method, recommend the flood discharge for this project. [9]

   A table for reduced mean ($\bar{y}_n$) and reduced standard deviation (S_n) is given below:

N	40	41	42	43	44	45
$\bar{y}_n$	0.5436	0.5442	0.5448	0.5453	0.5458	0.5463
S_n	1.1413	1.1436	1.1458	1.1480	1.1499	1.1519

   b) Explain log pearson III distribution and its use in the prediction of flood. [5]

7. For what purpose time area method is used? Explain time area method using a time area histogram of a catchment and a set of effective rainfall hydrograph over it. Comments on its drawbacks. [1+5+2]

SATURATION VAPOR PRESSURE OF WATER

Temperature		Saturation vapor pressure, e_s		Slope
°C	°F	mb	mm of Hg	(mm Hg/°F)
0	32	6.11	4.58	0.30
5.0	41.0	8.72	6.54	0.45
7.5	45.5	10.37	7.78	0.54
10.0	50.0	12.28	9.21	0.60
12.5	54.5	14.49	10.87	0.71
15.0	59.0	17.05	12.79	0.80
17.5	63.5	20.00	15.00	0.95
20.0	68.0	23.38	17.54	1.05
22.5	72.5	27.25	20.44	1.24
25.0	77.0	31.67	23.76	1.40
27.5	81.5	36.71	27.54	1.61
30.0	86.0	42.42	31.82	1.85
32.5	90.5	48.89	36.68	2.07
35.0	95.0	57.07	42.81	2.35
37.5	99.5	64.46	48.36	2.62
40.0	104.0	73.14	55.32	2.95
45.0	113.0	94.91	71.20	3.66

MEAN MONTHLY SOLAR RADIATION INCIDENT AT THE EARTH'S OUTER SPACE (EXTRATERRESTRIAL RADIATION), I_o IN MM OF EVAPORABLE WATER/DAY, IN NORTHERN HEMISPHERE WITH L = 560 CAL/G.

	North latitude (°N)									
Month	90°	80°	70°	60°	50°	40°	30°	20°	10°	0°
January	—	—	—	1.3	3.6	6.0	8.5	10.8	12.8	14.5
February	—	—	1.1	3.5	5.9	8.3	10.5	12.3	13.9	15.0
March	—	1.8	4.3	6.8	9.1	11.0	12.7	13.9	14.8	15.2
April	7.9	7.8	9.1	11.1	12.7	13.9	14.8	15.2	15.2	14.7
May	14.9	14.6	13.6	14.6	15.4	15.9	16.0	15.7	15.0	13.9
June	18.1	17.8	17.0	16.5	16.7	16.7	16.5	15.8	14.8	13.4
July	16.8	16.5	15.8	15.7	16.1	16.3	16.2	15.7	14.8	13.5
August	11.2	10.6	11.4	12.7	13.9	14.8	15.3	15.3	15.0	14.2
September	2.6	4.0	6.8	8.5	10.5	12.2	13.5	14.4	14.9	14.9
October	—	0.2	2.4	4.7	7.1	9.3	11.3	12.9	14.1	15.0
November	—	—	0.1	1.9	4.3	6.7	9.1	11.2	13.1	14.6
December	—	—	—	0.9	3.0	5.5	7.9	10.3	12.4	14.3

MEAN MONTHLY VALUES OF POSSIBLE SUNSHINE HOURS, N

Latitude North	Month											
(°N)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0°	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
10°	11.6	11.8	12.1	12.4	12.6	12.7	12.6	12.4	12.9	11.9	11.7	11.5
20°	11.1	11.5	12.0	12.6	13.1	13.3	13.2	12.8	12.3	11.7	11.2	10.9
30°	10.4	11.1	12.0	12.9	13.7	14.1	13.9	13.2	12.4	11.5	10.6	10.2
40°	9.6	10.7	11.9	13.2	14.4	15.0	14.7	13.8	12.5	11.2	10.0	9.4
50°	8.6	10.1	11.8	13.8	15.4	16.4	16.0	14.5	12.7	10.8	9.1	8.1

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03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Engineering Hydrology *(CE606)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Normal graph papers will be provided.*
- ✓ *Assume suitable data if necessary.*

1. What is hydrological cycle? Draw a neat sketch of the cycle showing all components. [1+3]

2. a) How would you determine optimum number of rain gauges to be installed in a given catchment? [6]

   b) Explain Intensity Duration Curve and Depth Area Curve. [6]

3. a) What is the difference between potential evapotranspiration (PET) and Actual evapotranspiration (AET)? Explain the penman's method for the estimation of PET from an area. [2+4]

   b) The infiltration of a catchment can be represented by the equation $f = 15+50e^{-0.9t}$. If the rainfall intensity of 45mm/hr occurs continuously for 10 hour from a catchment of area 12km^2, calculate [2+2+2+2]

   i) Total runoff volume generated from that catchment
   ii) Total infiltration volume at the period
   iii) Calculate time from the start of rainfall from which runoff started
   iv) Show your all (above three) results in infiltration curves

4. a) The stage and discharge data of a river are given below. Derive the equation of rating curve (stage-discharge relationship) to predict the discharge for a given stage. Assume the value of stage for zero discharge as 161.0m. [8]

Stage (m)	161.3	161.7	161.9	162.8	163.4	163.8	164.5	165.4	165.7
Discharge (m^3/s)	30	120	210	450	650	825	900	1000	1050

   b) Describe the principle of slope-area method for the measurement of flood discharge in a stream. Explain the procedure to compute peak discharge using method. [3+3]

5. A 1 hour unit hydrograph of a small catchment is triangular with peak value of 3.6 m^3/s occurring at 2 hours from the start and a base time of 6 hours. Following urbanization over a period of two decades, the infiltration index φ has decreased from 0.7cm/h to 0.4cm/h. Also one hour unit hydrograph has now peak of 6.0 m^3/s at 1 hours from start and time of base is 4 hours. If a design storm has intensities of 4cm/hour and 3cm/h for two consecutive one hour intervals. [14]

   a) Estimate the percentage increase in the peak storm runoff due to urbanization.
   b) The volume of flood runoff due to urbanization.

6. The project life of headworks is 50 years. The flood discharges at risk 63.58303% is 4200 cumes. The average flood is 3500 cumec, which is derived from long term historical data using Gumbel distribution. Calculate the discharge from 500 year return period and risk 39.49939%. Prepare a Gumbel graph paper using normal arithmetic graph paper. Plot these three discharges on Gumbel paper. [14]

7. What is linear reservoir? Explain the procedure to obtain Clark UH from time area method. [2+6]

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03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Engineering Hydrology *(CE 606)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What is a water balance equation? Write its significance in engineering hydrology. [4]

   b) Estimate the average depth of precipitation over the drainage basin with following data. [4]

Isohyetals (Intervals, cm)	15-12	12-9	9-6	6-3	3-1
Inter-isohyetal area (km^2)	92	128	120	175	85

   c) A catchment has seven rain gauges. In a year the annual rainfalls in cm, recorded at these gauses are 130, 142.1, 118.2, 108.5, 165.2, 102.1 and 146.9. For a 5% error in the estimation of mean rainfall, calculate the minimum number of additional rain gauges required to be established in the watershed. [4]

   d) Explain the use of Double Mass Curve with sketch. [4]

2. a) Discuss briefly the various hydrological losses from precipitation. [4]

   b) Estimate daily evaporation from a lake at 30°N for April by Penman method with following mean monthly data. [6]

T_a, Kelvin	RH, %	n, hrs	u_2, m/s	H_a, mm/ day	N, hrs
293	65	10	1.2	14.8	12.9

   c) A storm with 20 cm of precipitation produced a surface runoff of 12cm. Estimate the Φ index of the storm. [4]

Storm time(hr)	1	2	3	4	5	6	7	8
Rainfall (cm/hr)	0.7	2.2	3.0	4.6	3.6	3.2	2.0	0.7

3. a) Define rating curve and explain its uses in hydrology. [4]

   b) Determine the stage corresponding to zero discharge for following data of a smooth rating curve. [5]

Stage (m)	20.80	21.42	21.95	23.37	23.00	23.52	23.90
Discharge (m^3/s)	100	200	300	400	600	800	1000

   c) Differentiate Velocity-Area and Slope-Area methods of flow estimation. [5]

4. The ordinates of a 6-h unit hydrograph are given below. A storm had three successive 6-h intervals of rainfall magnitude of 3.0, 5.0 and 4.0cm respectively. Assuming an index of 0.20cm/h and a base flow of $30 m^3/s$. Determine and plot the resulting hydrograph of flow. [14]

Time (hr)	0	3	6	9	12	18	24	30	36	42	48	54	60	66
6-h UH ordinate m^3/s	0	150	250	450	600	800	700	600	450	320	200	100	50	0

5. a) Briefly describe the procedure of flood estimation by Log Pearson III method. [5]

b) A highway-bridge has to be designed with an expected life of 50 years and an allowable flood risk of 4%. The flood data of bridge site were well fitted to Gumbel EV distribution and discharges for 50 and 300 years return period are found to be 150 and 650m^3/sec respectively. Estimate the frequency and magnitude of design flood for the bridge. [9]

6. A drainage basin has area =157km^2, storage constant K= 9.5h and time of concentration = 7h. The following isochrones area distribution data are available. Determine the IUH of this catchment. [8]

Time(h)	0-1	1-2	2-3	3-4	4-5	5-6	6-7
Inter-isochrone area (km^2)	10	38	20	45	32	10	2

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63 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2067 Mangsir

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Engineering Hydrology

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. The following are the ordinates of the hydrograph of flow from a catchment area of 700km^2 due to a 6-h rainfall. [16]

Time(Hour)	0	6	9	12	18	24	30	33	36	42	48	54	60	66	72
Discharge(m^3/s)	40	65	140	215	360	400	350	330	270	205	145	100	70	50	40

a) Derive the ordinates of 6-h unit hydrograph
b) Calculate the flood hydrograph for two successive storms of 9.5 and 12.5 cm of 6 hours duration rainfall and an average storm loss of 0.25cm/hr

2. a) Describe the statistical approach for estimating the floods of required frequencies (design floods) when annual maximum floods of few years are available. [8]

b) Compute the stream flow from following data. The calibrated equation of current meter is: V = 0.045 + 0.76N, where V is in m/sec and N is revolution/sec. [8]

Distance from bank (m)	0	0.6	1.5	2.5	3.5	5.0	6.0	7.0	7.5
Depth (m)	0	0.3	0.75	1.2	1.7	1.3	0.7	0.3	0
No. of Revolutions	0	15	95	110	120	110	80	20	0
Time (sec)	0	45	85	95	90	100	70	40	0

3. a) Describe various forms of precipitation. [4]

b) A-4 hour storm occurs over a 80km^2 watershed. The details of the catchment are as follows. [12]

Sub basin(km^2)	ϕ index (mm/h)	Hourly Rainfall (mm)			
		1st hour	2nd hour	3rd hour	4th hour
15	10	16	48	22	10
25	15	16	42	20	8
35	21	12	40	18	6
5	16	15	42	18	8

Calculate the runoff from the catchment and the hourly distribution of the effective rainfall for the whole catchment.

4. a) In a recuperation test, the static water level in an open well was depressed by pumping by 3m and it recuperated 1.5m in 1 hour. If the diameter of the well is 3.0m and the safe working depression head is 2.4m, find out the average yield of the pump. [8]

b) Describe the hydro-geo-morphological characteristics of rivers with sketches. [8]

5. a) Calculate the discharge of a stream having a high water surface elevations noted at two sections A and B, 10km apart. These elevations and other salient hydraulic properties are given below. [8]

Section	Water Surface elevation (m)	Area of x-section (m^2)	Hydraulic Radius (m)
A	104.77	73.293	2.733
B	104.500	93.375	3.089

The eddyless coefficient is 0.3 for gradual expansion, 0.1 for gradual contraction and Manning's roughness is 0.02.

b) How is the double mass curve technique used to check the consistency and adjust the rainfall at a suspicious station? Explain with sketch. [8]

6. a) What is a rating curve? Write down a standard equation for a rating curve. Explain in detail the procedure to estimate the parameters of that rating equation. [1+1+8]

b) Prepare a Gumbel probability paper from an ordinary graph paper provided to you. [6]

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0825

03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2067 Shrawan

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Engineering Hydrology

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. A 1-hour unit hydrograph of a small catchment is triangular with peak value of 3.6 m^3/s occurring at 2 hours from the start and a base time of 6 hours. Following urbanization over a period of two decades, the infiltration index φ has decreased from 0.7cm/h to 0.4cm/h. Also one hour unit hydrograph has now peak of 6.0 m^3/s at 1 hour from start and time of base is 4 hours. If a design storm has intensities of 4cm/hour and 3cm/h for two consecutive one hour intervals, estimate [16]
   a) the percentage increase in the peak storm runoff due to urbanization.
   b) the volume of flood runoff due to urbanization.
2. a) Briefly describe the role of ground water in irrigation development. [6]
   b) Calculate the daily potential evaporation by Penman method using following data: Latitude = 27.5°N, Elevation = 1400m above mean sea level, mean monthly temperature = 10°C, relative humidity = 70%, mean observed sunshine hour = 7h, wind velocity at 2m height = 80 km/day, the ground surface is observed with green grass, Albedo = 0.15. Saturated vapor pressure at 10°C = 11.4mm of hg, Slope of saturated vapor pressure = 1.24 mm/°C, Psychrometric constant = 0.49mm/°C, and Boltzman constant = 2.01×10^{-9} mm/day. [10]
3. a) In a 140-minute storm, the following rates of rainfall were observed in successive 20-minute intervals: 3.0, 3.0, 9.0, 6.6, 1.2, 1.2 and 6.0 mm/hr. Assume the ϕ index value as 3.0 mm/hr and an initial loss of 0.8mm. Determine the total rainfall, net runoff and w-index for the storm. [6]
   b) For a drainage basin of 600km^2, isohyetals drawn for a storm gave the following data: [4]

Isohyetals intervals (cm)	15-12	12-9	9-6	6-3	3-1
Inter-isohyetals area (km^2)	92	128	120	175	85

   Find the average rainfall over the basin.
   c) What is rating curve? What are the factors affecting run off? Explain. [2+4]
4. a) Followings are the data obtained from a stream gauging station. A current meter with a calibration equation V = (0.32N + 0.032)m/s where N = revolutions per second, was used to measure the velocity at 0.6 depth. Calculate the discharge in the stream. [10]

Distance from right bank (m)	0	2	4	6	9	12	15	18	20	22	23	24
Depth (m)	0	0.5	1.1	1.95	2.25	1.85	1.75	1.65	1.50	1.25	0.75	0
No. of Revolutions	0	80	83	131	139	121	114	109	92	85	70	0
Time (sec.)	0	180	120	120	120	120	120	120	120	120	150	0

   b) Explain slope area method for estimating discharge of a stream. [6]

5. Using 30 years data and Gumbel's method the flood magnitudes, for return periods of 100 and 50 years for a river are found to be 1200 and 1060 m^3/sec respectively. ($\bar{y}_n = 0.5362$ and $S_n = 1.1124$). [16]

   a) Determine the mean and standard deviation of the data used.
   b) Estimate the magnitude of a flood with a return period of 500 years.
   c) What are the 95% confidence limits for this estimate if f(95%) = 1.96.
   d) What is the probability of the flood equal to or greater than a 500-year flood occuring three times in the next 10 years?

6. a) A 30cm well fully penetrates an unconfined aquifer of saturated depth 25m. When a discharge of 2100 lpm was being pumped for a long time, observation wells at radial distances of 30 and 90m indicated drawdowns of 5 and 4m respectively. Estimate the co-efficient of permeability and transmissibility of the aquifer. What is the drawdown at the pumping well? [10]

   b) Describe the four important hydro-geomorphological characteristics of a river. [6]

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0805

03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2066 Magh

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Engineering Hydrology

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- ✓ *Attempt any **Five** questions.*
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- ✓ *Assume suitable data if necessary.*

1. Unit hydrograph of 3h duration from a catchment area of 524.88 ha has peak discharge value after 9 hours from the start of the storm. It has half of the peak discharge value at 3 hours and 15 hours after the start of storm respectively. If time base (t_b) is 30 hours, constitute the unit hydrograph and calculate the flood hydrograph from the following rainfall data. Assume the Phi index (ϕ) as 0.333 cm/hour and base flow as 20 cumecs. [16]

Time (hours)	0	6	9	12
Cumulative Rainfall (cm)	0	12	12	23

2. The project life of a headworks is 50 years. The flood discharges at the risks 63.6% and 39.5% are 4200 cumecs and 5800 cumecs respectively, which is derived from long term historical data using Gumbel distribution. Calculate the discharge from 500 years return period. Plot these three discharges on Gumbel paper. [16]

3. a) Write down the factors affecting evapotranspiration. [4]

   b) Calculate the potential evapotranspiration for an area over Kathmandu in the month of February by Penman Method. The following data is available. [12]

   Mean Monthly Temperature : 12.5°C
   Mean RH : 70%
   Mean Sunshine Hours : 7 h
   Potential Sunshine Hours : 11.9 h
   Wind Velocity at 2m Height = 120 km/day
   Albedo : 0.15
   Upper Terrestrial Solar Radiation : 9mm of water/day

   Other values:

   Latitude : 28.50
   Longitude : 84.50
   Saturated Vapor Pressure at 12.5°C : 11.4mm of Hg
   Slope of Saturated Vapor Pressure : 1.24mm/°C
   Psychrometric Constant : 0.49mm/°C
   Boltzman Constant : 2.0×10^{-9} mm/day

4. a) Depth of a triangular shaped river is 3m. Its top width is 10m. The maximum depth of the river is at 4m from the one side. The top velocity of the river measured at 3.0 and 7.0m from the same side are 1.5m/s and 1.8m/s respectively. Calculate the discharge of the river. [8]

   b) Explain slope area method for discharge calculation. [8]

5. a) Explain different types of rain gauges with neat sketch. [8]

   b) There are four rain gauges at four corner of a rectangle. The two sides of rectangle are 100km and 150km. The yearly rainfalls of four gauges are 1200mm, 1300mm, 1500mm and 1100mm respectively. Calculate the average rainfall by Theissen polygon method. [4]

   c) Explain Φ (Phi)-index and W-index. [4]

6. a) Explain hydrological cycle. [4]

   b) Define floods. Enumerate the causes, effects and mitigation of floods. [1+5]

   c) In a recuperation test, the static water level in an open well was depressed using pumps by 3m and it recuperated 1.5m in 1 hour. If the diameter of the well is 3.0m and the safe working depression head is 2.4m, find out the average specific yield of the soil and specific capacity of the soil. [6]

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