TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

Exam.	Back		
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.*
- ✓ *Semi-log graph is provided.*
- ✓ *Assume suitable data if necessary.*

1. a) In a certain catchment, inflow rate into the catchment due to rainfall is given by equation $I=2t$ m^3/s. If loss n the catchment is neglected, determine the change is storage in catchment with in 3 hr duration. [4]

   b) Justify the uses of Hydrology in Engineering Design. [3]

2. For a station A, the recorded annual 24 hr maximum rainfalls are given below. [8]

   Estimate the 24 hr maximum rainfall with return periods of 50 years by using provided semi log graph.

Year	1950	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
Ppt (cm)	13.0	12.0	7.6	14.3	16.0	9.6	8.0	12.5	11.2	8.9	8.9	7.8	9.0	10.2	8.5	7.5

3. a) Calculate PET for May month by Penman method.
   Mean monthly temperature = 20°C
   Mean RH = 75%
   Mean Sunshine hoar = 10 hr.
   Potential Sunshine hour = 13.5 hr.
   Wind velocity at 2m height = 8 km/hr.
   Albedo = 0.028
   Upper terrestrial solar radiation = 14.4 mm of Hg/day
   Latitude = 27°; Longitude = 86°
   Saturated vapour pressure at 20°C = 11mm of Hg
   Slope of Saturated vapour pressure = 1.42 mm/°C [8]

   b) A storm with a 15.0 cm precipitation produced a direct runoff of 8.7cm. The time distribution of storm is as follows.

Time from start (hr)	1	2	3	4	5	6	7	8
Incremental rainfall in each hr (cm)	0.6	1.35	2.25	3.45	2.7	2.4	1.5	0.75

   Estimate the Φ-index of the storm. [5]

4. a) Define catchment. What are the factors affecting runoff from a catchment? [1+5]

   b) For the purpose of discharge measurement in a stream by Slope-Area method the following data has been obtained. [8]

	U/S Section	Middle Section	D/S Section
Area (m^2)	105.75	102.63	96.63
Wetted perimeter (m)	64.25	60.20	58.00
Gauge Reading (m)	315.5	-	315.15
Manning's Roughness	0.025	0.027	0.029

   Determine the stream discharge for length between U/S and D/S sections as 260 m assuming coefficient of contraction K_c as 0.1.

   c) Define shifting control in stage discharge relationship. What are the causes of shifting control? [1+2]

5. a) Define unit hydrographs and explain the uses of hydrograph. [5]

   b) The ordinates of a 4 hr UH of a basin area of 300 km^2. Three hundred square km measured at 1-hr internals are 6, 36, 66, 91, 106, 93, 79, 68, 58, 49, 41, 34, 27, 23, 17, 13, 9, 6, 3 and 1.5 m^3/s respectively. Obtain the ordinates of a 3 hr UH of the basin using the s-curve technique. [10]

6. a) In the time series data of annual peak flood for 75 years, the mean and standard deviations are found to be equal to 5561 m^3/s and 1718 m^3/s respectively. Using $\overline{yn} = 0.556$ and S_n=1.189 (for 75 yrs). [4+4]

      i) Determine the peak flood for 0.4% probability of exceedence by Gumbel's method.

      ii) Compute 90% confidence limits for above floods, using f(c) = 1.6 for 90% confidence level respectively.

   b) Explain the rational method of determining the floods. Also write down its limitations. [6]

7. A drainage Basin has the following characteristics: [6]
   Area = 110 Km^2, Time of concentration = 18 h, Storage time constant = 12 h and inter-isochrones area distribution as below:

Travel Time (h)	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18
Inter-isochrone area (km^2)	3	9	20	22	16	18	10	8	4

   Determine the Clark's 2h-IUH for this catchment.

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

Exam.	Back		
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 <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ ***<u>Semi-log graph is provided.</u>***
- ✓ *Assume suitable data if necessary.*

1. a) In a certain catchment, inflow rate into the catchment due to rainfall is given by equation I=2t m^3/s. If loss n the catchment is neglected, determine the change is storage in catchment with in 3 hr duration. [4]

   b) Justify the uses of Hydrology in Engineering Design. [3]

2. For a station A, the recorded annual 24 hr maximum rainfalls are given below. [8]

   Estimate the 24 hr maximum rainfall with return periods of 50 years by using provided semi log graph.

Year	1950	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
Ppt (cm)	13.0	12.0	7.6	14.3	16.0	9.6	8.0	12.5	11.2	8.9	8.9	7.8	9.0	10.2	8.5	7.5

3. a) Calculate PET for May month by Penman method.
   Mean monthly temperature = 20°C
   Mean RH = 75%
   Mean Sunshine hoar = 10 hr.
   Potential Sunshine hour = 13.5 hr.
   Wind velocity at 2m height = 8 km/hr.
   Albedo = 0.028
   Upper terrestrial solar radiation = 14.4 mm of Hg/day
   Latitude = 27°; Longitude = 86°
   Saturated vapour pressure at 20°C = 11mm of Hg
   Slope of Saturated vapour pressure = 1.42 mm/°C [8]

   b) A storm with a 15.0 cm precipitation produced a direct runoff of 8.7cm. The time distribution of storm is as follows.

Time from start (hr)	1	2	3	4	5	6	7	8
Incremental rainfall in each hr (cm)	0.6	1.35	2.25	3.45	2.7	2.4	1.5	0.75

   Estimate the Φ-index of the storm. [5]

4. a) Define catchment. What are the factors affecting runoff from a catchment? [1+5]

   b) For the purpose of discharge measurement in a stream by Slope-Area method the following data has been obtained. [8]

	U/S Section	Middle Section	D/S Section
Area (m^2)	105.75	102.63	96.63
Wetted perimeter (m)	64.25	60.20	58.00
Gauge Reading (m)	315.5	-	315.15
Manning's Roughness	0.025	0.027	0.029

   Determine the stream discharge for length between U/S and D/S sections as 260 m assuming coefficient of contraction K_c as 0.1.

   c) Define shifting control in stage discharge relationship. What are the causes of shifting control? [1+2]

5. a) Define unit hydrographs and explain the uses of hydrograph. [5]

   b) The ordinates of a 4 hr UH of a basin area of 300 km^2. Three hundred square km measured at 1-hr internals are 6, 36, 66, 91, 106, 93, 79, 68, 58, 49, 41, 34, 27, 23, 17, 13, 9, 6, 3 and 1.5 m^3/s respectively. Obtain the ordinates of a 3 hr UH of the basin using the s-curve technique. [10]

6. a) In the time series data of annual peak flood for 75 years, the mean and standard deviations are found to be equal to 5561 m^3/s and 1718 m^3/s respectively. Using $\overline{yn} = 0.556$ and S_n=1.189 (for 75 yrs). [4+4]

      i) Determine the peak flood for 0.4% probability of exceedence by Gumbel's method.

      ii) Compute 90% confidence limits for above floods, using f(c) = 1.6 for 90% confidence level respectively.

   b) Explain the rational method of determining the floods. Also write down its limitations. [6]

7. A drainage Basin has the following characteristics: [6]
   Area = 110 Km^2, Time of concentration = 18 h, Storage time constant = 12 h and inter-isochrones area distribution as below:

Travel Time (h)	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18
Inter-isochrone area (km^2)	3	9	20	22	16	18	10	8	4

   Determine the Clark's 2h-IUH for this catchment.

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

Exam.	Regular / Back		
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 <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ ***<u>A seperate graph paper is provided.</u>***
- ✓ *Assume suitable data if necessary.*

1. Explain hydrologic cycle with neat sketches and justify its need in Engineering Hydrology. [3+2]

2. The rainfall depth with time during a storm at a station is given below. Compute maximum average intensities of the rainfall for durations 30 minutes, 1hr, 2 hr, and 5hr and plot the resulting intensity duration curve. [6]

Time (hr)	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00
Rainfall (mm)	0	6	6	5	8	5	9	13	6	4	3	2	0

3. a) Explain the water budget and energy budget methods for estimation of evaporation. [3+3]

   b) The mass curve of an isolated storm in a 500ha watershed is as follows:

Time from strat (h)	0	2	4	6	8	10	12	14	16	18
cumulative rainfall (cm)	0	0.8	2.6	2.8	4.1	7.3	10.8	11.8	12.4	12.6

   If runoff measured at the outlet is $0.361 Mm^3$ is baseflow, estimate the ϕ-index of the storm and duration of rainfall excess. Also determine W-index if the other losses in the storm is $0.1\ Mm^3$. [5+1]

   c) Differentiate actual and Potential Evapotranspirations. [3]

4. a) Following are the data of gauge and discharge collected at a particular section of the river by stream gauging operation. [6+2]

   i) Develop a gauge-discharge relationship for this stream at this section for use in estimating the discharge for a known gauge reading. What is the coefficient of correlation of the derived relationship? Use a =7.5m for the gauge corresponding to zero discharge.

   ii) Estimate the discharge corresponding to a gauge reading of 10.5m at this gauging station.

Gauge reading (m)	Discharge (m^3/s)	Gauge reading (m)	Discharge (m^3/s)
7.65	15	8.48	170
7.7	30	8.98	400
7.77	57	9.30	600
7.8	39	9.5	800
7.9	60	10.5	1500
7.91	100	11.1	2000
8.08	150	11.7	2400

b) Calculate the discharge in a stream by using mid-section method from provided data. A current meter is used to measure velocity at 0.6 depth and calibrated as V=0.3N+0.004 [8]

Distance from right bank (m)	0	2	4	6	9	12	15	18	20
Depth (m)	0	0.50	1.10	1.90	2.2	1.8	1.1	0.7	0
Number of revolutions	0	80	83	130	121	116	100	90	0
Time (s)	0	170	110	100	100	100	100	90	0

5. a) Define storm hydrograph, direct runoff hydrograph and baseflow. Explain the methods to separate base flow strom hydrograph with clear sketches. [3+3]

b) Following are the ordinates of hydrograph from a catchment area of 770km^2 due to 6-hr rainfall. Derive the ordinates of flood hydrograph due to 3.3cm and 5.5cm effective rainfall of duration 12-hr. [10]

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

6. a) Explain Rational method of flood predication . Also mention its limitations & uses. [3+3]

b) Analysis of the annual flood peak of river of 21 years yielded a mean of 8520m^3/s and standard deviation of 3900m^3/s. A proposed water control project on this river is to have an expected life of 40 years. The acceptable reliability by the design policy is 85%. [4+4]

i) Using Gumbel's Method recommend the flood discharge for this project. Take y_n=0.5252 and S_n=1.0696 for 21 years.

ii) What would the 80% confidence limit of the above flood if f(c)=1.282 at 80% confidence level.

7. a) What do you understand by flow routing? [2]

b) A drainage basin has the following characteristics:
Area = 123 km^2, time of concentration=14 hr, storage constant=10h and inter-isochrone area distribution as below:

Travel Time (hr)	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18
Inter-isochrone area (km^2)	4	10	21	24	18	20	12	9	5

Compute the flood hydrograph by using Clark's IUH. [6]

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Examination Control Division
2076 Ashwin

Exam.	Back		
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.*
- ✓ *Semi-log graph is provided.*
- ✓ *Assume suitable data if necessary.*

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   b) Justify the uses of Hydrology in Engineering Design. [3]

2. For a station A, the recorded annual 24 hr maximum rainfalls are given below. [8]

   Estimate the 24 hr maximum rainfall with return periods of 50 years by using provided semi log graph.

Year	1950	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
Ppt (cm)	13.0	12.0	7.6	14.3	16.0	9.6	8.0	12.5	11.2	8.9	8.9	7.8	9.0	10.2	8.5	7.5

3. a) Calculate PET for May month by Penman method.
   Mean monthly temperature = 20°C
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   Latitude = 27°; Longitude = 86°
   Saturated vapour pressure at 20°C = 11mm of Hg
   Slope of Saturated vapour pressure = 1.42 mm/°C [8]

   b) A storm with a 15.0 cm precipitation produced a direct runoff of 8.7cm. The time distribution of storm is as follows.

Time from start (hr)	1	2	3	4	5	6	7	8
Incremental rainfall in each hr (cm)	0.6	1.35	2.25	3.45	2.7	2.4	1.5	0.75

   Estimate the Φ-index of the storm. [5]

4. a) Define catchment. What are the factors affecting runoff from a catchment? [1+5]

   b) For the purpose of discharge measurement in a stream by Slope-Area method the following data has been obtained. [8]

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   b) The ordinates of a 4 hr UH of a basin area of 300 km^2. Three hundred square km measured at 1-hr internals are 6, 36, 66, 91, 106, 93, 79, 68, 58, 49, 41, 34, 27, 23, 17, 13, 9, 6, 3 and 1.5 m^3/s respectively. Obtain the ordinates of a 3 hr UH of the basin using the s-curve technique. [10]

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   Area = 110 Km^2, Time of concentration = 18 h, Storage time constant = 12 h and inter-isochrones area distribution as below:

Travel Time (h)	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18
Inter-isochrone area (km^2)	3	9	20	22	16	18	10	8	4

   Determine the Clark's 2h-IUH for this catchment.

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04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 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. a) Define hydrology and write on history of hydrometeorology studies in Nepal. [5]

   b) Describe with a neat sketch the principle of working of a tipping bucket type recording rain gauge. What are its advantages and disadvantages? [6]

   c) A catchment area has seven rain gauge stations. In a certain month the precipitation record of station D could not be measured due to the failure of instrument. Estimate the missing precipitation of D from the following data available given in the table below. [5]

Stations	A	B	C	D	E	F	G
Monthly Ppt. (cm)	12	8.5	7.6	-	5.2	8.8	9.7
Annual normal Ppt. (cm)	188	210	152	175	246	270	228

2. a) In a 3.5 hr storm following rates of rainfall were observed in successive 30 min intervals as 4, 4, 12, 8.5, 5, 5, and 8.6 mm/hr respectively. Assuming ϕ-index of 4mm/hr and the initial loss of 1.2 mm; determine the total rainfall, net runoff and W-index. [6]

   b) Explain the use of a lysimeter in measuring evapotranspiration. [5]

   c) During a daily routine observation 10.8 litres of water was added to bring the water surface in the evaporation pan to the stipulated level and the nearby raingauge measured 3.6 mm of rainfall. What was the evaporation recorded for the day if the diameter of the pan is 122 cm? [5]

3. a) During a high flow water surface elevations of a stream of trapezoidal section with base width of 10m and side slope 2:1 (H:V) were noted at two sections A and B, 10 km apart as below. Find the flow discharge in the stream. [8]

Sections	Elevation of Bed (m)	Water Surface Elevation (m)	Remarks
A	503.25	505.95	Manning's Constant = 0.025
B	502.85	504.20	Eddy loss coefficient of 0.30 for expansion and 0.10 for contraction.

   b) Write the equation of the rating curve and explain with figure how the stage for zero discharge is determined? [6]

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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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**.*
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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) Compute the stream discharge with the following data. [6]

Distance from left bank	0	2	4	6	8	10	12
Depth (m)	-	0.9	2.4	2.2	1.0	0.6	-
Velocity at 0.2d	-	0.6	0.9	0.7	0.6	0.4	-
Velocity at 0.8d	-	0.4	0.6	0.5	0.4	0.3	-

b) Explain briefly the basic principles involved in the developments of IUH by Clarks' method. [4]

c) Following coordinates are obtained from a stream gauging stations: ($4m^3/s$, 9.55m), ($8m^3/s$, 9.75m) and ($16m^3/s$, 10.15m). Determine the equation of rating curve and compute the discharge in the stream corresponding to a stage of 10.40m. [6]

5. a) Explain the MIP and WECS methods to determine the mean monthly flows of an ungauged river basin. [4]

b) A bridge has an expected working life of 40 years and is designed for a peak flood of 100 years return period. Estimate the risk of failure of this bridge. If a risk of 15% is acceptable, what should be the return period for it? [6]

c) 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. [6]

Time (h)	0	6	12	18	24	30	36	42	48	54
Inflow (m3/sec)	14	27	60	150	135	115	85	65	30	15

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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.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *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: $\propto = \frac{1.28255}{\sigma}; \beta = \mu - 0.48\sigma$] [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
INSTITUTE OF ENGINEERING
Examination Control Division
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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04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 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**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. a) Justify the importance of study of Hydrology in civil engineering work. [4]

   b) The catchment area of a reservoir is 1400 ha. A uniform precipitation of 6 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 0.5 $mm/h/m^2$. Assuming seepage loss is 45% of evaporation loss, find the change in the reservoir level for 6 hours, if the water spread of the reservoir was 45ha. [6]

2. Annual rainfall at station X and the average of the annual rainfall at 15 nearby rain gauge stations for a period of 35 years is given below. [8+3+4]

   i) Examine the consistency of the data at station X
   ii) In which year did a change in regime occur? Discuss the possible reasons
   iii) Determine the average annual rainfall at X for 35 years first without adjusting the data and later with adjustment for the change regime.

3. How you will interpret the Energy balance in a water body? Develop the relation for daily Lake Evaporation using Energy-Budget method. [2+5]

4. a) What are the factors that affect the runoff from a catchment? [3]

   b) The data pertaining to a stream-gauging operation at a gauging site are given below. The rating equation of the current meter is $v = (0.55\ N+0.04)$ m/s where N is revolution per second, Calculate the discharge in the stream. [8]

Dist form Left edge (m)	0	1.0	4.0	7.0	10.0	13.0	16.0	17.0
Depth (m)	0	1.5	2.5	3.5	2.4	2.2	1.3	0
Revolution of current meter at 0.6d	0	40	60	120	125	50	40	0
Duration of observation (s)	0	100	100	150	150	100	100	0

   c) Define rating curve and describe its uses. [3]

5. The ordinate of 4n-uH are given: [16]

Time (hr)	0	2	4	6	8	10	12	14	16	18	20	22	24
Ordinate (m^3/s)	0	30	100	150	200	160	120	80	40	30	20	6	0

A catchment has rainfall of 3.5, 2.5 and 4.5 cm in three consecutive two hours period. Assuming an average ϕ index of 1.25 cm/hr and base flow of river is 50 m^3/s, Determine the flood hydrograph of the catchment.

6. a) The data of observed flood peaks of a river for a period of 30 years is found to plot as a straight line on semi-log paper with return period plotted on the logarithmic scale. The largest and smallest floods in the record are 1170 m^3/s and 195 m^3/s respectively. If 1350 m^3/s respectively. If 1350 m^3/s is selected as a design flood, what is the probability of its being exceeded during the next 20 years? [7]

b) Prove that for a large sample as per Gumbel's distribution, the mean annual flood will have a return period of 2.33 years. [5]

7. Explain the procedure of obtaining Clark IUH. [6]

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Year	Annual rainfall (mm) at X	Annual rainfall (mm) 15 stations average	Year	Annual rainfall (mm) at X	Annual rainfall (mm) 15 stations average
1946	664	593	1964	534	562
1947	552	530	1965	491	481
1948	558	565	1966	519	484
1949	578	534	1967	456	481
1950	570	562	1968	545	582
1951	555	478	1969	534	514
1952	639	600	1970	453	496
1953	687	552	1971	474	532
1954	572	524	1972	466	540
1955	524	502	1973	478	484
1956	570	532	1974	554	621
1957	743	611	1975	433	486
1958	534	534	1976	437	600
1959	496	501	1977	458	434
1960	468	486	1978	545	547
1961	532	583	1979	560	636
1962	423	484	1980	435	478
1963	473	610			

04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
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.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

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
Inflow (m^3/sec)	14	27	60	150	135	115	85	65	30	15

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04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

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)*

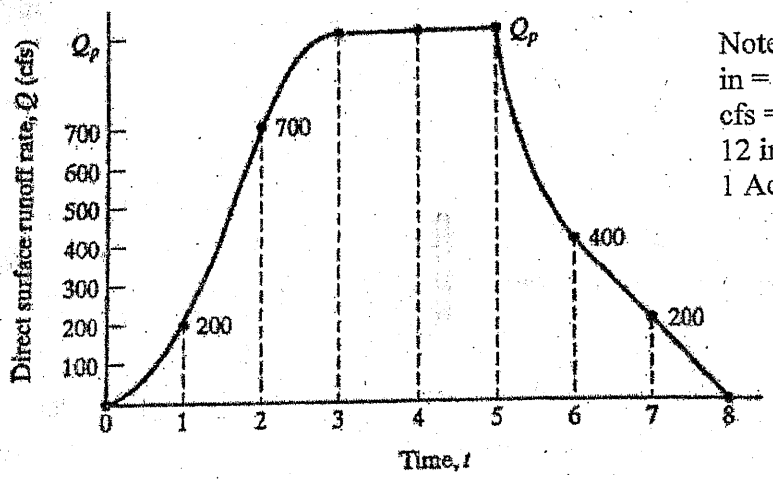
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

120

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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03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

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**.*
- ✓ *Assume suitable data if necessary.*

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		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	10.5	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	10.3	12.2	13.5	14.4	14.9	14.9
October	—	0.2	2.4	4.7	7.1	9.4	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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120

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)*

- ✓ 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 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

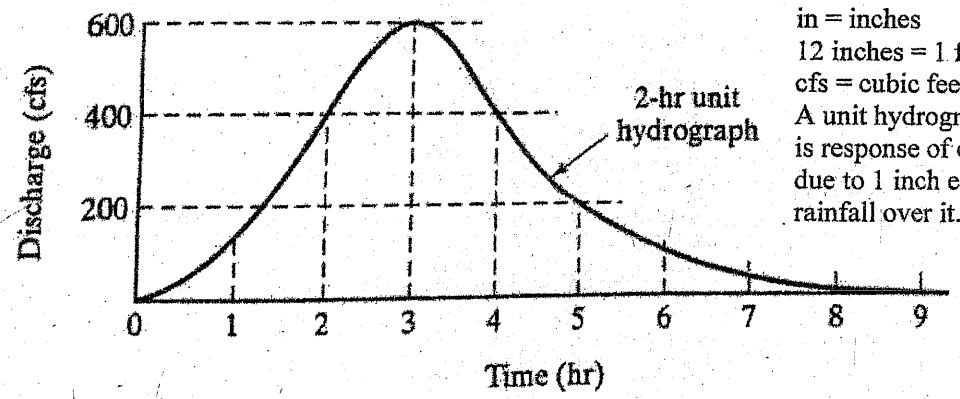
   b) Explain how the monthly flows from the ungauged locations are estimated from the observed rainfall data over the catchment, in Nepal. [6]

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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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
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
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 Jestha

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) The ordinates of a 4-h UH of a catchment of area 105km^2 are given in the table below. Derive 2-h total Runoff Hydrographs from: (i) rainfall excess of 3.5 cm occurring in 4 hrs duration and (ii) Rainfall excess of 3.5cm occurring in 2 hr duration, and a base flow of 12m^3/sec. [12]

t, hrs	0	4	8	12	16	20	24	28	32	36	40	44	48	52
Q, m^3/s	0	30	55	90	130	170	180	160	110	60	35	20	8	0

   b) Describe the hydrological cycle with neat sketch. [4]

2. a) The flood discharges for 25 and 250 years from fitted Gumbel distribution are 90 and 500m^3/sec respectively. Estimate the flood magnitudes for 50, 500 and 1000 years by Gumbel analytically. [8]

   b) A storm with following distribution of rainfall produced a surface runoff of 12cm. Estimate the ϕ index of the storm. [8]

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

3. a) The normal annual rainfall at four stations A, B, C and D in a basin was observed as 75.8, 62.4, 70.7 and 87.3cm respectively. In a particular year, the station D remained inoperative and the rainfall at stations A, B and C was recorded as 85.3, 66.5 and 75.2 respectively. Estimate the missing rainfall at station D. [4]

   b) Describe slope area method of estimating discharge with neat sketch? Differentiate this method with Velocity-Area method? [12]

4. a) For the Horton model, the infiltration rate at the begining of rainfall is 10cm/hr and decreases to 1cm/hr after 10 hours. A total of 70cm of water infiltrated during the 10 hour period. Compute the value of k of the Horton model. [6]

   b) Derive the formula for discharge from a fully penetrating well operating under steady state in a confined aquifer with neat sketch showing all components. [4]

   c) What are the metrological parameters used in Penman's equation? Describe the use of this equation. [6]

5. a) Determine the stage corresponding to zero discharge from the following data of this equation. [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) Describe the factors affecting runoff from a catchment. [8]

6. Write short notes on any four of the following: [4×4]

   a) Rational method for estimating design flood
   b) Flood control and mitigation methods
   c) Double Mass Curve
   d) Recharge of ground water
   e) Evaporimeters

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03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Bhadra

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. a) The ordinates of 6-h UH are given as follows: [12]

Time (hours)	0	3	6	9	12	15	18	21	24	27	30	33	36
6 –hr UH ordinates	0	15	24	42	58	78	69	58	43	30	17	15	0

A storm has successive 3-hr rainfall of 3, 5 and 4cm respectively. ϕ-index is 0.2 cm/hr, base flow is 53 m^3/s. Determine the resulting flow hydrograph.

b) Write down the hydrogeomorphological factors that affect the stability of stream or river. [4]

2. The data series of peak runoff in a stream was recorded as shown in the following table. Plot the observed peak flow versus return period and Gumbel extreme value fit curve. Comment on the model applicability of the data series. [16]

Year	Peak discharge	Year	Peak discharge
1926	16.64	1939	8.34
1927	11.03	1940	17.40
1928	8.63	1941	70.75
1929	44.14	1942	52.35
1930	20.99	1943	6.90
1931	7.64	1944	15.33
1932	8.54	1945	10.61
1933	229.51	1946	4.30
1934	130.74	1947	10.92
1935	29.99	1948	11.26
1936	21.08	1949	35.37
1937	11.09	1950	7.47
1938	175.46		

Take $\bar{y}_n = 0.5308$ and $\sigma_n = 1.091$

3. a) Three points on rating curve of a stream gauging station obtained from observed data have the following co-ordinates ($2m^3/s$, 10.65m), ($4m^3/s$, 10.85m) and ($8m^3/s$, 11.25m). Determine the equation of the rating curve and compute the discharge in the stream corresponding to a stage of 11.5m [Use $Q = C_r (G-a)^{\beta}$ as the equation of rating curve]. [6]

b) List out the causes of shifting control in gauge stream discharge measurement and its relationship. [2]

c) A semi circle of diameter of 40 km with an equilateral triangle of side of 40km below its diameter is a close approximation to a river basin. The position co-ordinates of 5 rain gauge stations A, B, C, D and E located within the basin with respect to a coordinate axes system whose X axis and Origin coincident with diameter and centre of the circle are (10, 10), (-10, 10), (-10, -10), (10, -10) and (0, 0) km respectively. If the rainfall recorded at these rain gauges are 80, 95, 76, 82, 107mm respectively, determine the average depth of rainfall using Thiessen polygon method. [8]

4. a) Define equivalent depth of water for certain snow depth. Calculate the equivalent water depth, if snow depth is 0.5m, density of snow and water are 200kg/m^3 and 1000 kg/m^3 respectively. [1+3]

b) A stream is assumed to be trapezoidal in cross section having bed width of 12m and side slope 2 horizontal: 1 vertical in reach of 1km. During flood time, high water levels recorded at both ends of the reach are: [8]

Section	Elevation of bed (m)	Water surface elevation (m)
u/s	100.20	102.70
d/s	98.60	101.30

If Manning's n = 0.03, estimate the discharge in the stream.

c) Write down the limitations of rational method for determination of peak flood and its application in civil engineering designs. [4]

5. a) The steady state discharge from a pumping well is 0.025m^3/s. Following are the draw downs obtained from the multiple observation well test of confined aquifer. [8]

r(m)	15	30	60	100	160	200
s(m)	1.05	0.95	0.71	0.535	0.36	0.29

Where r = distance of observation wells from pumping well and s = drawdown. Calculate radius of influence and transmissibility of the aquifer.

b) Show that $F = \frac{f_o - f_c}{k}$ in which F is the total infiltration depth above the $f_t = f_c$ of Horton's equation. Assume that the depth of soil is infinite. Where, f_o = initial infiltration capacity, f_c = final steady state infiltration and k = Horton's constant depending on soil characteristics. [6]

c) What assumptions did Penman use in deriving his evaporation formula? [2]

6. a) Define Hydrology and explain its application in civil engineering fields. [1+3]

b) Write short notes on use of Gamma distribution in flow analysis. [4]

c) A reservoir has following average meteorological values during a given week. [1+2]

Saturated vapour pressure (e_s) = 31.82mm of Hg
Relative Humidity = 50%
Wind velocity at 1m above ground = 12km/h

Determine actual vapour pressure and wind velocity at 9m above ground.

d) Prove that the specific yield of an open well from recuperation test is $\frac{C}{A} = \frac{1}{T} \ln \frac{s_1}{s_2}$, where [5]

s_1 = draw down in well when pumping was stopped
s_2 = draw down in well after time T from the stopping of pump
A = cross section area of well
C = specific capacity of well

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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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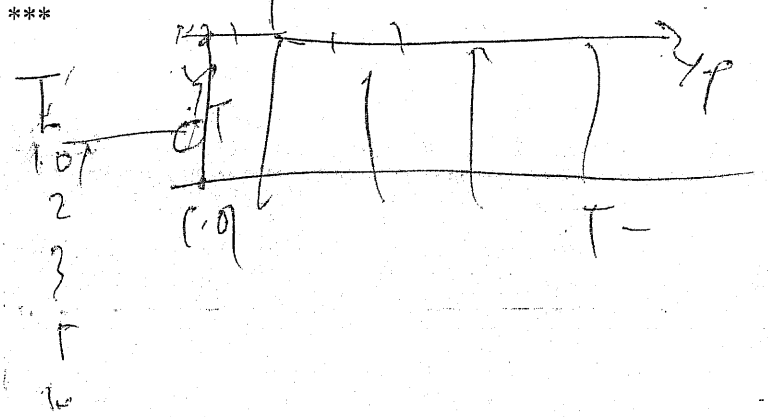

03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2066 Kartik

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. The expected life of a diversion weir is 50 years. At 20% and 40% risk, the discharge of the river is 1200 and 1060 m^3/s. [8+8]
   a) Determine the mean and standard deviation of the data used.
   b) Estimate the magnitude of flood with a return period of 500 years.
2. Ordinate of an 2 hour unit hydrograph at 1-hour interval are 5, 8, 5, 3 and 1 m^3/s. Calculate [2+7+7]
   a) Watershed area represented by the unit hydrograph
   b) 1 hour unit hydrograph for the catchment
   c) 3 hour unit hydrograph of the catchment
3. a) The characteristics of an Isolated 1-h storm occurred over a basin is given below in the table. [10]

% of catchment Area	ϕ index (cm/h)	rainfall (cm)	
		First 0.5 hour	Second 0.5 hour
10	1.0	0.8	1.5
20	1.25	0.75	2.25
30	0.5	1.0	0.8
40	0.75	1.0	1.5

   Calculate total rainfall, total losses and runoff from the catchment.
   b) Discuss double mass curve method of adjustment. [6]
4. a) Explain Velocity Area Method to calculate the discharge of the river. [8]
   b) Explain Slope Area Method to calculate the discharge of the river. [8]
5. a) Explain various geomorphological characteristics of rivers. [6]
   b) Calculate the ETo by Penman Method for April month at longitude 84.5°, latitude 27.25° and altitude 1390m. The other climatic data are as follows: [10]

   $T_{min} = 20°C$, $T_{max} = 30°C$
   $RH_{min} = 49\%$, $RH_{max} = 92\%$
   Wind Speed = 350 km/day at 2m height
   Sunshine Hour = 9.5, Potential sunshine hours: 11.0 hours

   Saturated Vapor Pressure (ea) = 31.0 mbar,
   Extra Terrestrial Radiation (Ra) = 15 mm/day, albedo = 0.25
   Slope of saturated vapor pressure = 1.4 mm/°C
   Stefan Boltzman constant: 2.01×10^{-9} mm/day

   Assume if any data missing
6. a) Explain Rational Method of calculating flood discharge. [6]
   b) Write down the Dupit's assumptions. [2]
   c) Derive expressions for well discharge for steady flow in confined and unconfined aquifers. [8]

03 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2065 Kartik

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. The following are the ordinates of the hydrograph of flow from a catchment area of 770km^2 due to a 12-h rainfall. [16]

Time (Hour)	0	6	12	18	24	30	36	42	48	54	60	66	72
Discharge (m^3/s)	50	75	225	370	410	360	280	215	155	110	80	60	50

   a) Derive the ordinates of 12-h unit hydrograph.
   b) Calculate the flood hydrograph for two successive storms of 9.0 and 12.0cm of 12 hours duration rainfall each and an average storm loss of 1cm in 3 hours.

2. An analysis of an annual flood series covering the period 1900 to 2000 (100 years) on a certain river shows that the 100-year flood has a magnitude of 640,000 m^3/s and 2.0 year has a magnitude of 225,000 m^3/s. Assume the annual floods fit with Gumbel distribution. [16]
   a) What is the probability of having a flood as great as or greater than 440,000 m^3/s?
   b) What is the magnitude of the flood having a recurrence interval of 50 years?
   c) What is the probability of having 575,000 m^3/s flood or a greater flood in coming 25 years time?
   d) Find the mean and standard deviation of the annual floods and occurrence interval of the mean flood.

3. a) How would you determine optimum number of rain gauges to be installed in a given catchment. [4]
   b) Differentiate between recording rain gauge and non recording rain gauge. [4]
   c) The infiltration rate for excess rain on a small catchment area was observed to be 9.0 cm/hr at the beginning of rain and it is decreased expontantially to be an equilibrium of 1 cm/hr after 10 hours interval. Determine the value of Horton constant. [8]

4. a) Explain the stream flow measurement by velocity area method. [8]
   b) A small stream has rectangular section having 10m width in a reach of 5km and Manning roughness coefficient 0.03. During a flood the high water level records at the end of the reach as given below. Estimate the flood discharge of the river. [8]

Section	elevation of bed	water surface elevation
U/S	100.2m	102.7m
D/S	98.6m	101.3m

5. a) Write down the steps with formula to calculate evapotranspiration from Penman method. [8]
   b) 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]

6. Write short notes: [16]
   a) Hydrological Cycle
   b) Double Mass Curve
   c) Rational methods of peak discharge estimation
   d) Hydro geomorphological characteristics of river

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2065 Chaitra

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 ordinates of 6 hr unit hydrograph of a catchment area of 770 km^2 are given below. [4+6+

Time	0	6	12	18	24	30	36	42	48	54	60	66	72
Discharge ordinate m^3/sec	0	5	35	64	72	62	46	33	21	11.6	5.6	1.6	0

Assuming the constant base flow of 40 m^3/sec.

a) What is the magnitude of peak discharge produced by a 6 hr storm yielding 5cm of rainfall with ϕ-index of 0.30cm?
b) Derive 18 hour U-H by method of superposition.
c) Derive 18 hour U-H by using S-curve method.

2. Flood frequency records on a river have been collected for 17 years starting from 1951 to 1967 and the peak values of the flood observed during each of these 17 years are given below.

Year	1951	1952	1953	1954	1955	1956	1957	1958	1959
Peak discharge (m^3/sec)	3000	4400	6000	3500	2900	4800	3900	3300	6700
Year	1960	1961	1962	1963	1964	1965	1966	1967	
Peak discharge (m^3/sec)	5400	4300	3700	4200	9000	4000	3600	5100	

a) Prepare a Gumbel's extreme value probability paper.
b) Estimate graphically 100 year and 500 year flood. Take mean and standard deviation of Gumbel's reduced variate as 0.518 and 1.041 respectively.

3. a) How would you determine optimum number of rain gauges to be installed in a given catchment? [4]

b) Explain the stream flow measurement by velocity area method. [4]

c) During a high flow, water surface elevation of a small stream were noted at two stations A and B, 10km apart. Elevations and other silent features are given below. [8]

Section	Water Surface Elevation (m)	Area of cross section (m^2)	Hydraulic radius (m)	Remarks
A	104.771	73	2,7	A is U/S of B. Roughness Coeff. N = 0.20
B	104.500	93	3.1	

Take the eddy coefficient of 0.30 for gradual expansion and 0.10 for gradual contraction. Estimate the discharge in the stream.

4. a) The ordinates of a rainfall mass curve of a storm over a basin of area 850km^2 measured in mm at one hour interval are: [12]

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_0 = 6.5mm/h, f_c = 1.5mm/h and K = 0.15/h, estimate the resulting runoff volume. [12]

b) Discuss any two procedures available to estimate the missing precipitation records. [4]

5. a) Describe the methods of recharging underground water storage. [8]

b) 30cm wall penetrates 20m below the static water table. After 24 hrs. of pumping at 5000 litres per minutes, the water level in the test well of 100m away is lowered by 0.5m and in a well of 30m away the drawdown is 1m. What is the transmissibility of the aquifer and also determine the drawdown in the main well. [8]

6. Write short notes on: [4×4]

a) Rating curve
b) Penmann's equation
c) Flood mitigation
d) Application of hydrology in Engineering

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63 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2064 Poush

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 stream flows due to three successive storms of 4.5, 6.5 and 3.5cm of 6 hours duration each on basin is given below. The area of the basin is 45.4 km^2. Assuming the constant base flow of 20 m^3/s and an average storm loss of 0.25 cm/hr. [16]

Time	0	6	12	18	24	30	36	42	48	54	60	66	72
Discharge (cumec)	25	105	365	925	1255	985	739	555	403	265	165	75	25

   a) Derive the ordinates of a 6-hour unit hydrograph of the basin.
   b) Calculate the flood hydrograph for storms of 11.5cm of 12 hours duration rainfall.

2. The following peak discharge represents the annual maximum flows for the of a river from year 1961 to 1975: [16]

Year	61	62	63	64	65	66	67	68
Flows (m^3/s)	4510	7060	4550	3500	3420	3880	2740	3650
Year	69	70	71	72	73	74	75	
Flows (m^3/s)	4350	2660	8030	3090	4080	2930	2410	

   a) Calculate the 10-, 50-, and 100-year discharge assuming Gumbel distribution.
   b) Calculate the 2-, 10-, 50-, and 100-year discharge using Weibull Plotting position method.

   Note: The reduced mean and reduced S.D. for 15 samples are 0.53 and 1.10 respectively.

3. a) Write down the factors affecting evaporation. [4]
   b) Calculate daily potential evaporation by Penman method from an area having the following characteristics. [12]

   Latitude = 30°N, Elevation = 300m above mean sea level, mean monthly temperature = 15°c, relative humidity = 70%, mean observed sunshine hour = 9h, wind velocity at 2m height = 50 km/day and the ground surface is observed with green grass. Furthermore,

   Saturated vapor pressure at 15°C = 13.4mm of Hg
   Slope of saturated vapor pressure = 1.24 mm/°C
   Psychrometric constant = 0.49 mm/°C
   Boltzman constant = 2.01×10^{-9} mm/day
   Albedo = 0.15

4. a) Calculate the average rainfall over a catchment of area 8 km^2 by three methods. [8]

Station ID	Annual Rainfall (mm)	Isohetal		Polygon Area (%)
		Interval (m)	Area enclosed (sqkm)	
A	2256	1.80-2.0	1.25	15
B	2534	2.00-2.2	0.75	31
C	2123	2.2-2.4	3.15	21
D	1867	2.4-2.6	0.85	11
E	2000	2.6-2.8	2.0	22

b) Compute the discharge of a stream with following data. A current meter with calibration equation V = 0.30N +0.032 where V in m/s and N in Revolutions/s is used to measure the velocity. [8]

Distance (m)	0	2	4	6	8	10	12	14	16	18	20	22
Depth (m)	0	1	4.3	7.2	8.5	7.4	5.6	4.7	3.5	2.1	1.4	0
Revolutions/second at 0.2d	0	3	4	6	6.5	7	6	5.5	5	3	2	0
Revolutions/second at 0.8d	0	2	3	5	5.5	6.5	6.3	4.8	4	2.5	1.5	0

5. a) The average rainfall over 45ha of watershed for a particular storm was as follows. [6]

Time (hr)	0	1	2	3	4	5	6	7
Rainfall (cm)	0	0.5	1	3.25	2.5	1.5	0.5	0

The volume runoff from this storm was determined as 2.25ha-m. Establish the ϕ-index.

b) Write down the assumption of Dupuit formula and derive a well discharge equation for steady state condition for confined and unconfined aquifer. [10]

6. Write down four short notes: [4×4]

a) Mass curve and its uses
b) Development of hydrology in Nepal
c) Ordinary flood, standard flood and probable maximum flood
d) S curve and its uses
e) Pumping and recuperation test

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