CE462A Project #1

Tarun Rambali Yadav
201048

Problem set #2

Data set#2

Part A) Fitting IDF Curve

Methodology:

1) Fit the data to Gumbel and Log Normal Distribution.

2) Check AIC BIC values and chose distribution for duration based on lower value

3) Make IDF curve using the best fit distributions.

4) Fit IDF curve to the form $i_{D,T} = \frac{K*T^x}{(D+a)^n}$ using desmos.

D (hours)		0.08333	0.16667	0.25	0.5	1	2	6	12	24
Gumbel	AIC	487.582	438.38	441.163	396.653	346.664	328.73	227.438	182.726	176.175
	BIC	491.771	442.568	445.352	400.842	350.853	332.919	231.627	186.915	180.363
LogNormal	AIC	493.188	438.313	441.474	396.553	348.902	322.891	229.215	181.145	176.217
	BIC	497.377	442.501	445.662	400.741	353.091	327.08	233.404	185.334	180.406
MIN	AIC	487.582	438.313	441.163	396.553	346.664	322.891	227.438	181.145	176.175
	BIC	491.771	442.501	445.352	400.741	350.853	327.08	231.627	185.334	180.363
BEST FIT		Gumbel	Log Norm	Gumbel	Log Norm	Gumbel	Log Norm	Gumbel	Log Norm	Gumbel

T (year) /D (min)	5	10	15	30	60	120	360	720	1440
2 years	23.3199	22.1036	21.3336	19.0888	17.1782	15.7787	6.67182	4.43263	3.45743
5 years	36.3714	31.261	29.8857	25.3432	21.4538	18.9962	8.20003	5.4289	4.42815
10 years	45.0126	37.4707	35.5478	29.39	24.2847	20.9313	9.21184	6.03583	5.07086
25 years	55.9308	45.4575	42.702	34.4198	27.8614	23.2126	10.4903	6.758	5.88291
50 years	64.0305	51.5007	48.0094	38.118	30.5148	24.8168	11.4387	7.26984	6.48534

D	I	T
5	23.3199281	2
10	22.1036072	2
15	21.3336428	2
30	19.08879179	2
60	17.17822937	2
120	15.77867197	2
360	6.67181663	2

$$I \sim k \cdot \frac{T^c}{(D+a)^n}$$

STATISTICS

$R^2 = 0.9782$

RESIDUALS

e_1 plot

PARAMETERS

$k = 121.588$

$c = 0.229237$

$a = 17.2111$

$n = 0.513228$

Part B) Designing storm water drainage system using triangular gutter and curb inlet

Methodology:

1) Obtain time of concentrations for each sub-catchment using IDF curve and Manning's equation
2) Obtain design flow using rational method.
3) Find the spread for the flow by fixing cross slope as 0.035 and longitudinal slope as 0.0015.
4) Find depth as $T*S_x$. Provide sufficient free board.
5) Find flow velocity and flow time.
6) Continue for other gutters.
7) Design Curb opening inlets assuming no bypass flow.

Surface	Run-off coefficient
Residential	0.5
Lawn	0.2
Paved	0.9

Basin	Area of the basin (Hectares)	Division of basin area (%)		Drainage Len (m)	Slope of the basin	Manning's coefficient for basin	C
I	0.9	Residential	58	87.2	0.01	0.039	0.44
		Lawn and open spac	32				
		Paved street	10				
II	0.85	Residential	60	85.6	0.01	0.032	0.436
		Lawn and open spac	32				
		Paved street	8				
III	0.4	Residential	40	40.3	0.01	0.025	0.39
		Lawn and open spac	50				
		Paved street	10				
IV	0.84	Residential	65	83.2	0.01	0.03	0.451
		Lawn and open spac	27				
		Paved street	8				
V	0.9	Residential	55	86	0	0.035	0.435
		Lawn and open spac	35				
		Paved street	10				

Catchment	tc	i	C
I	18.7867	27.9509198	0.444
II	17.2179	28.5974863	0.436
III	9.2395	32.7406095	0.39
IV	14.2249	29.9639383	0.451
V	31.455	23.943553	0.435

Sewer	Directly drained or contribut in upstream sewer	Area Aj (km^2)	Runoff Coefficient (Cj)	Cj*Aj	∑Cj*Aj	Inlet Time (min)	Upstream Sewer Flow Time (min)	Time of Concentration tc (min)	Design Rain Duration tD (min)	Design Rain Intensity (mm/hr)
11 to 21	I	0.009	0.444	0.003996	0.003996	18.7867	-	18.7867	18.7867	27.95092
21 to 31	III	0.004	0.39	0.00156		9.2395	-	9.2395		
	11	-	-	0.003996		18.7867	42.16037	60.94707		
					0.009552				60.94707	18.77557
23 to 31	II	0.0085	0.436	0.003706	0.003706	17.2179		17.2179	17.2179	28.59749
31 to 41	21	-	-	0.009552		9.2395	14.98125	24.22075		
	23	-	-	0.003706		17.2179	25.63024	42.84814		
					0.013258				42.84814	21.49332
44 to 41	IV	0.0084	0.451	0.003788	0.003788	14.2249		14.2249	14.2249	29.96394
54 to 41	V	0.009	0.435	0.003915	0.003915	31.455		31.455	31.455	23.94355
41 to 51	31	-	-	0.013258			16.67955	16.67955		
	44	-	-	0.003788			25.19401	25.19401		
	54	-	-	0.003915			30.83385	30.83385		
					0.020961				30.83385	24.10193

Gutter	Upstream manhole ground elevation (m)	Length L (m)	Slope S	Design Discharge Qp, m^3/s	Spread	Required Depth	Depth provided (required +free board)	Flow Velocity V (m/s)	Gutter Flow Time (min)	S*L (m)	Upstream curb top Elevation (m)	Upstream gutter bottom Elevation (m)	Downstream curb top Elevation (m)	Downstream gutter bottom Elevation (m)
11	137.1	1000	0.002	0.031026	2.117719	0.07412	0.2	0.395316	42.16037	2	137.1	136.9	135.1	134.9
21	136.5	400	0.0035	0.049818	2.529257	0.088524	0.2	0.445001	14.98125	1.4	136.5	136.3	135.1	134.9
23	131.6	600	0.004	0.02944	2.076456	0.072676	0.2	0.390164	25.63024	2.4	131.6	131.6	129.2	129.2
31	133.2	500	0.001	0.079155	3.008869	0.10531	0.2	0.499614	16.67955	0.5	133.2	129.2	132.7	128.7
44	129.5	600	0.0032	0.031532	2.130619	0.074572	0.2	0.39692	25.19401	1.92	129.5	128.7	127.58	126.78
54	132.6	700	0.0042	0.026039	1.983035	0.069406	0.2	0.378372	30.83385	2.94	132.6	126.78	129.66	123.84

Curb Opening Inlet

$$L_T = K_o Q^{0.42} S_L^{0.3} (n S_x)^{-0.6}$$

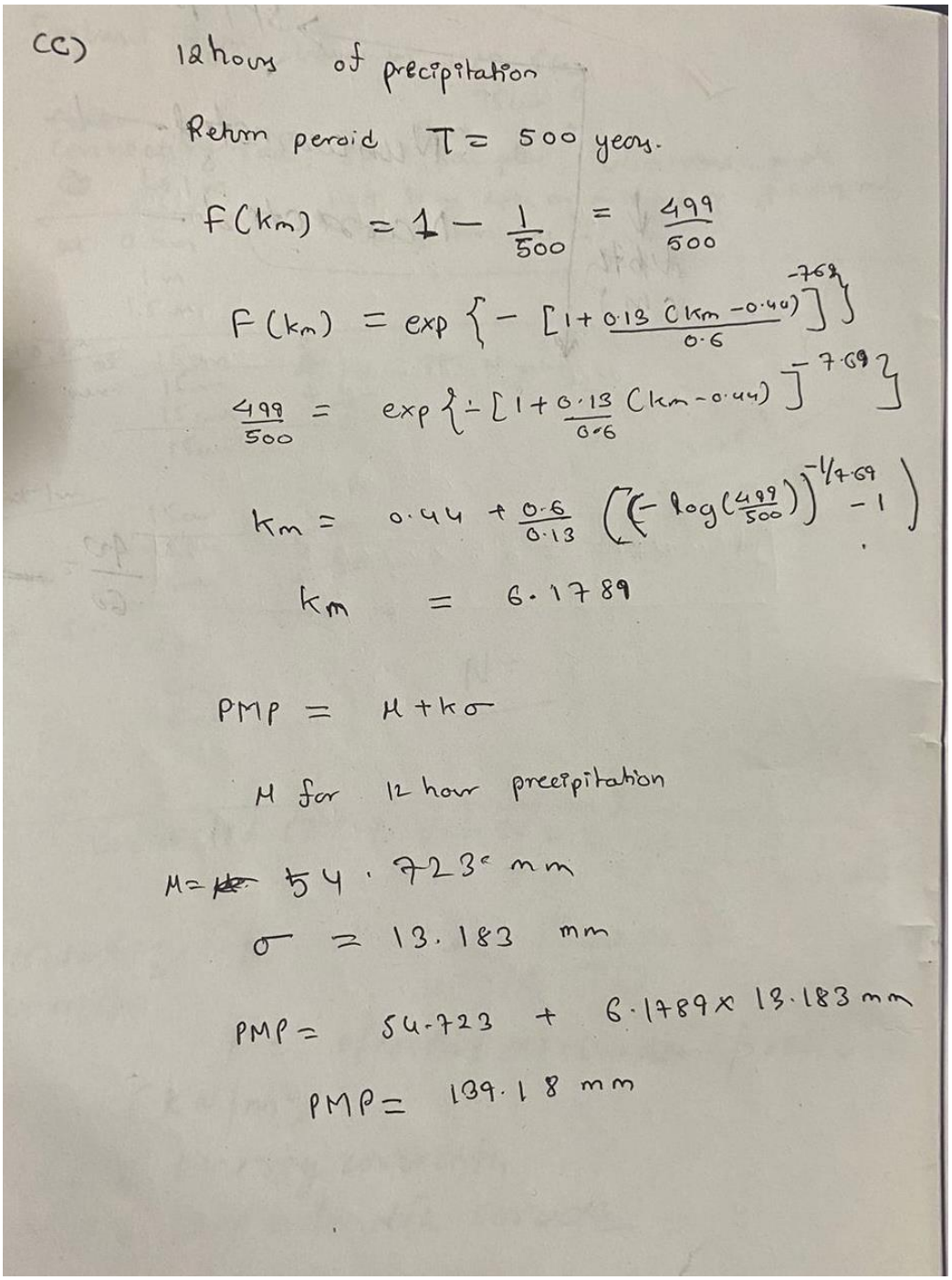
Gutter	L-t (m)
11	2.733787
21	3.335372
23	2.674198
31	4.051388
44	2.752444
54	2.539815

Design of sewer pipes

Sewer	Directly drained or contributin upstream sewer	Area Aj (km^2)	Runoff Coefficien t (Cj)	Cj*Aj	∑Cj*Aj	Inlet Time (min)	Upstream Sewer Flow Time (min)	Time of Concentration tc (min)	Design Rain Duration tD (min)	Design Rain Intensity (mm/hr)
11 to 21	I	0.009	0.444	0.003996	0.003996	18.7867	-	18.7867	18.7867	27.95092
21 to 31	III	0.004	0.39	0.00156		9.2395	-	9.2395		
	11	-	-	0.003996		18.7867	85.436722	104.2234218		
					0.009552				104.223	14.975376
23 to 31	II	0.0085	0.436	0.003706	0.003706	17.2179		17.2179	17.2179	28.597486
31 to 41	21	-	-	0.009552		9.2395	26.684194	35.92369446		
	23	-	-	0.003706		17.2179	54.023676	71.24157617		
					0.013258				71.2416	17.620325
44 to 41	IV	0.0084	0.451	0.003788	0.0037884	14.2249		14.2249	14.2249	29.963938
54 to 41	V	0.009	0.435	0.003915	0.003915	31.455		31.455	31.455	23.943553
41 to 51	31	-	-	0.013258			20.424161	20.42416116		
	44	-	-	0.003788			50.438561	50.43856105		
	54	-	-	0.003915			71.259675	71.25967479		
					0.0209614				71.2597	17.618475

Sewer	Upstream manhole ground elevation (m)	Length L (m)	Slope S	Design Discharge Qp, m^3/s	Required Diameter/8 (m)	Provided Diameter (m)	Flow Velocity V (m/s)	Sewer Flow Time (min)	S*L (m)	Upstream Crown Elevation (m)	Upstrea m Invert Elevation (m)	Downstream Crown Elevation (m)	Downstrea m Invert Elevation (m)
11	137.1	1000	0.002	0.031026	0.2648611	0.45	0.1950761	85.43672183	2	135.6	135.15	133.6	133.15
21	136.5	400	0.0035	0.039735	0.26166309	0.45	0.2498358	26.68419446	1.4	133.6	133.15	132.2	131.75
23	131.6	600	0.004	0.02944	0.22804966	0.45	0.185104	54.02367617	2.4	130.6	130.15	128.2	127.75
31	133.2	500	0.001	0.064892	0.39777518	0.45	0.4080135	20.42416116	0.5	132.2	131.75	131.7	131.25
44	129.5	600	0.0032	0.031532	0.24399622	0.45	0.198261	50.43856105	1.92	128.5	128.05	126.58	126.13
54	132.6	700	0.0042	0.026039	0.21580629	0.45	0.1637205	71.25967479	2.94	131.6	131.15	128.66	128.21

Part C) Probable Maximum Precipitation



(c) 12 hours of precipitation

Return period $T = 500$ years.

$$f(k_m) = 1 - \frac{1}{500} = \frac{499}{500}$$

$$F(k_m) = \exp\left\{-\left[1 + \frac{0.13\,(k_m - 0.44)}{0.6}\right]^{-7.69}\right\}$$

$$\frac{499}{500} = \exp\left\{-\left[1 + \frac{0.13}{0.6}(k_m - 0.44)\right]^{-7.69}\right\}$$

$$k_m = 0.44 + \frac{0.6}{0.13}\left(\left(-\log\left(\frac{499}{500}\right)\right)^{-1/7.69} - 1\right)$$

$$k_m = 6.1789$$

$$PMP = \mu + k\sigma$$

μ for 12 hour precipitation

$\mu = 54.723$ mm

$\sigma = 13.183$ mm

$$PMP = 54.723 + 6.1789 \times 13.183 \text{ mm}$$

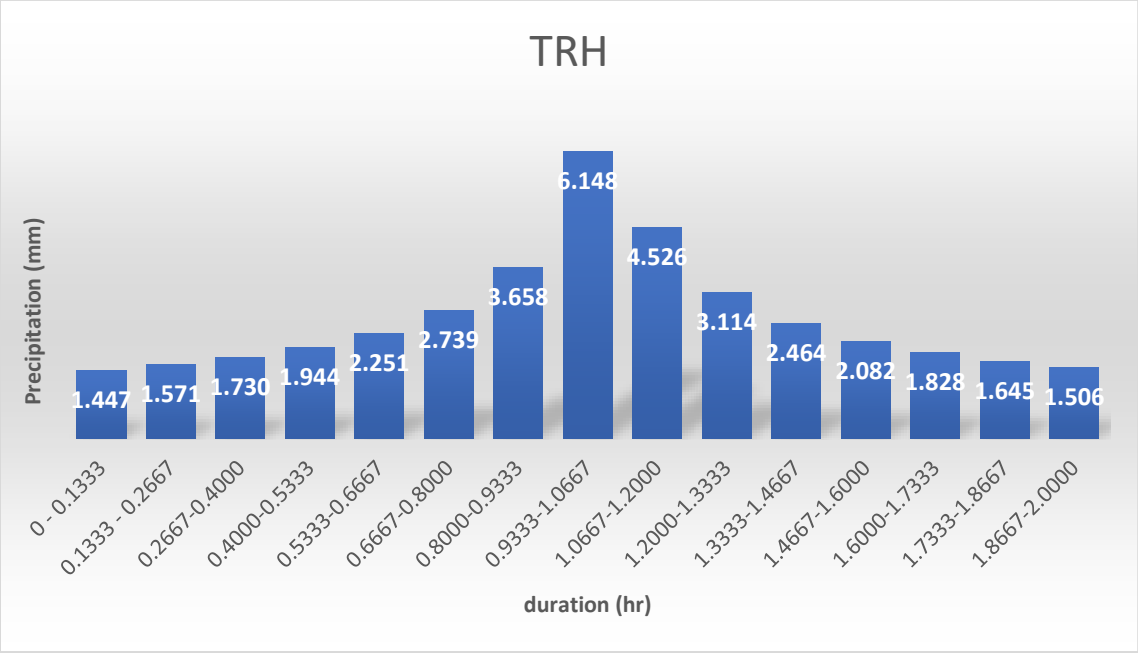
$$PMP = 139.18 \text{ mm}$$

Part D) Hyetograph through Alternating Block Method

Methodology:

1) Obtain incremental rainfall from IDF curve
2) Now sort the incremental rainfall.
3) Arrange the rainfall such that maximum is in center then next highest below and then above.

Duration (hr)	Intensity (mm/hr)	Cumulative Depth (mm)	Incremental Depth (mm)	Sorted	Time (hr)	Precipitation (mm)
0.1333	46.110388	6.148	6.148	6.148	0 - 0.1333	1.447
0.2667	40.028541	10.674	4.526	4.526	0.1333 - 0.2667	1.571
0.4000	35.831462	14.333	3.658	3.658	0.2667-0.4000	1.730
0.5333	32.713044	17.447	3.114	3.114	0.4000-0.5333	1.944
0.6667	30.279386	20.186	2.739	2.739	0.5333-0.6667	2.251
0.8000	28.312264	22.650	2.464	2.464	0.6667-0.8000	2.739
0.9333	26.679774	24.901	2.251	2.251	0.8000-0.9333	3.658
1.0667	25.296892	26.983	2.082	2.082	0.9333-1.0667	6.148
1.2000	24.10603	28.927	1.944	1.944	1.0667-1.2000	4.526
1.3333	23.066615	30.755	1.828	1.828	1.2000-1.3333	3.114
1.4667	22.149131	32.485	1.730	1.730	1.3333-1.4667	2.464
1.6000	21.331528	34.130	1.645	1.645	1.4667-1.6000	2.082
1.7333	20.596956	35.701	1.571	1.571	1.6000-1.7333	1.828
1.8667	19.932288	37.207	1.506	1.506	1.7333-1.8667	1.645
2.0000	19.327129	38.654	1.447	1.447	1.8667-2.0000	1.506



Part e)

Methodology:

1) Use TRH to obtain intensity of storm.
2) Use the intensity and catchment area and coefficient to find flow.
3) Check if flow exceeds capacity of gutter and inlet.

Duration (hr)	Intensity	Cumulative	Incremental	Sorted	Time (hr)	Precipitation
0.1333	46.1104	6.148	6.148	6.148	0 - 0.1333	1.447
0.2667	40.0285	10.674	4.526	4.526	0.1333 - 0.2667	1.571
0.4000	35.8315	14.333	3.658	3.658	0.2667-0.4000	1.730
0.5333	32.713	17.447	3.114	3.114	0.4000-0.5333	1.944
0.6667	30.2794	20.186	2.739	2.739	0.5333-0.6667	2.251
0.8000	28.3123	22.650	2.464	2.464	0.6667-0.8000	2.739
0.9333	26.6798	24.901	2.251	2.251	0.8000-0.9333	3.658
1.0667	25.2969	26.983	2.082	2.082	0.9333-1.0667	6.148
1.2000	24.106	28.927	1.944	1.944	1.0667-1.2000	4.526
1.3333	23.0666	30.755	1.828	1.828	1.2000-1.3333	3.114
1.4667	22.1491	32.485	1.730	1.730	1.3333-1.4667	2.464
1.6000	21.3315	34.130	1.645	1.645	1.4667-1.6000	2.082
1.7333	20.597	35.701	1.571	1.571	1.6000-1.7333	1.828
1.8667	19.9323	37.207	1.506	1.506	1.7333-1.8667	1.645
2.0000	19.3271	38.654	1.447	1.447	1.8667-2.0000	1.506

Total rainfall
38.654
total time
2hr

intensity (mm/h) = 19.3271