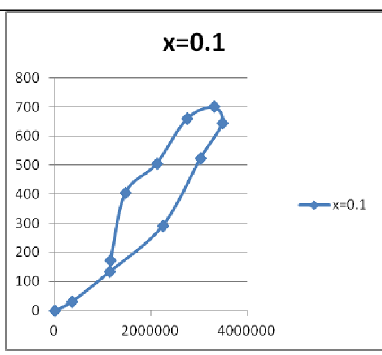
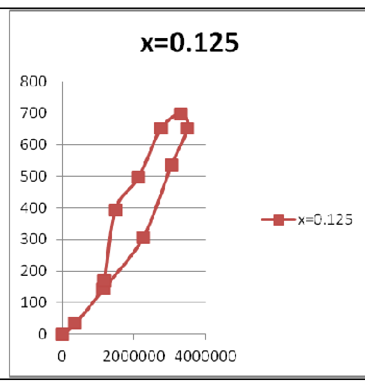
Problem One:

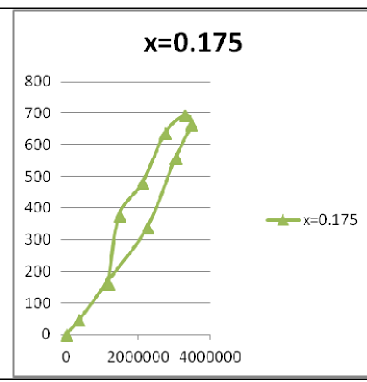
Assuming a routing time increment, Δt, of 30 min, determine the routing coefficient *x* and *K* for the Muskingum Method and the flowing hydrograph

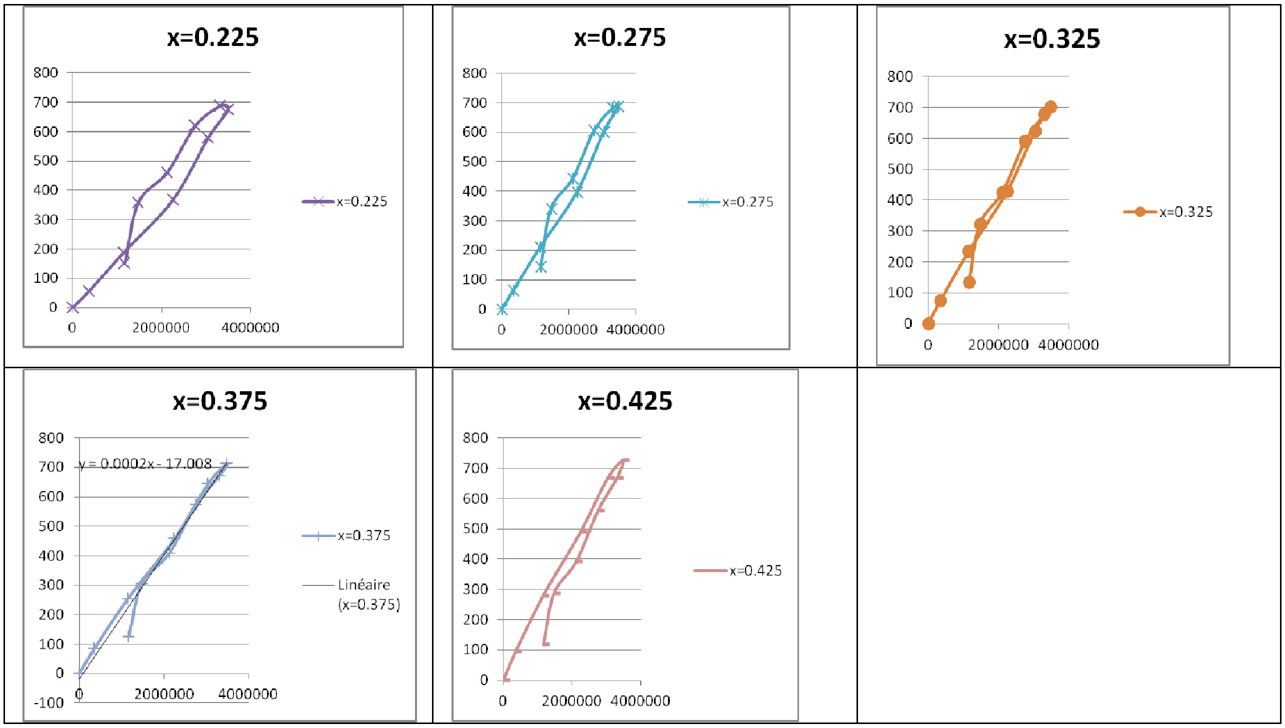
I (ft³/sec)	0	210	530	840	920	870	610	380	190	80	20
O(ft³/sec)	0	10	90	230	480	620	710	690	540	440	190

			Weighted discharge							
Inflow (ft3/s)	Outflow (ft3/s)	Storage (ft3)	x=0.2	x=0.225	x=0.275	x=0.325	x=0.375	x=0.425	x=0.475	
0	0	0	0	0	0	0	0	0	0	
210	10	360000	50	55	65	75	85	95	105	
530	90	1152000	178	189	211	233	255	277	299	
840	230	2250000	352	367.25	397.75	428.25	458.75	489.25	519.75	
920	480	3042000	568	579	601	623	645	667	689	
870	620	3492000	670	676.25	688.75	701.25	713.75	726.25	738.75	
610	710	3312000	690	687.5	682.5	677.5	672.5	667.5	662.5	
380	690	2754000	628	620.25	604.75	589.25	573.75	558.25	542.75	
190	540	2124000	470	461.25	443.75	426.25	408.75	391.25	373.75	
80	440	1476000	368	359	341	323	305	287	269	
20	190	1170000	156	151.75	143.25	134.75	126.25	117.75	109.25	









X=0.375	
1/K=slope (because the X-axis is S and the Y-axis is weighted discharge)	0.0002
K=	5000 s

PROBLEM 2

A portion of a river is modeled with two reaches, A and B. Reach A extends from section1 to section 2 and has a length of 20,000 ft, n = 0.07, S = 1 %, and Rh = 4 ft. Reach B extends from section 2 to section 3 and has a length of 15,000 ft, n = 0.05, S = 1% and Rh = 7 ft. The hydrograph at Section 1 is (200, 300, 700, 600, 500, 400, 350, 300, 250, 225, 210, 205, 200), with a time increment, Δt of 10 min. Assume the initial discharge at downstream sections is 200. Using the Convex Routing Method, (a) route the hydrograph from section 1 to section 2 and then from section 2 to section 3.

$$V = \frac{1.49}{n} Rh^{2/3}\sqrt{S}$$

$$V_A = \frac{1.49}{0.07}(4)^{2/3}\sqrt{\frac{1}{100}} = 5.36366\, ft/s$$

$$V_B = \frac{1.49}{0.05}(7)^{2/3}\sqrt{\frac{1}{100}} = 10.90473\, ft/s$$

$$K = \frac{L}{V} \rightarrow K_A = \frac{L_A}{V_A} = \frac{20000ft}{5.36366ft/s} = 3728.794\,\text{sec} = 62.1565\ min$$

$$K_B = \frac{L_B}{V_B} = \frac{15000}{10.90473} = 1375.5498sec = 22.9258\, min$$

$$C = \frac{u}{1.7+u} \rightarrow C_A = \frac{5.36366}{5.36366+1.7} = \frac{10\ min}{62.1565\ min} = 0.76;\ C_B = 0.86$$

$$C_A K_A = \Delta t_A \rightarrow \Delta t_A = 2832s;\ C_A^* = 1-(1-C_A)^{\frac{600+0.5*2832}{1.5*1800}} = 0.49$$

$$C_B K_B = \Delta t_A \rightarrow \Delta t_B = 1376s;\ C_B^* = 1-(1-C_B)^{\frac{600+0.5*1376}{1.5*1376}} = 0.74$$

$$Q_{t+dt} = CI_t + (1-C)Q_t$$

$$A:\ Q_{t+dt} = 0.49\, I_t + 0.51Q_t$$

$$B:\ Q_{t+dt} = 0.74\, I_t + 0.26Q_t$$

Time	Inflow Reach A	Outflow reach A=inflow Reach B	Outflow reach B
0	200	200	200
10	300	200	200
20	700	249	200
30	600	469.99	236.162
40	500	533.6949	408.727064
50	400	517.184399	500.953327
60	350	459.7640435	512.9318581
70	300	405.9796622	473.6940109
80	250	354.0496277	423.7208216
90	225	303.0653101	372.3034805
100	210	264.8133082	321.2057108
110	205	237.9547872	279.5881176
120	200	221.8069415	248.8627198

PROBLEM 3

A surface-storage facility has a rectangular bottom (*L* = 300 ft, *W* = 100 ft), with vertical ends (i.e., the length remains constant) and the sides with slopes of 20:1(h:v). The facility is used to control runoff from a residential area. Determine the stage-storage-discharge relationship assuming that outflow from the basin is controlled by a weir with a 9-ft length and C = 3.5. The weir invert is the same as the elevation of the bottom of the storage basin.

Assuming that the initial storage and discharge are zero, route the following hydrograph through the structure using the storage-indication method.

t (min)	0	15	30	45	60	75	90	105	120	135	150	165
q (ft3/sec)	0	30	75	120	175	160	125	85	55	35	20	10

Sample calculations (h=3)

$$A(h) = (100 \times 300)ft^2 + 2 \times (20 \times h\, ft \times 300ft)$$

$$A(h = 3ft) = 30000\, ft^2 + 12000ft \times 3ft = 66000\, ft^2$$

$$S(h) = 30000\, ft^2 \times h + 2 \times h\left(\frac{1}{2} \times 20h \times 300\right) = 30000 \times h\, ft^3 + 6000 \times h^2\, ft^3$$

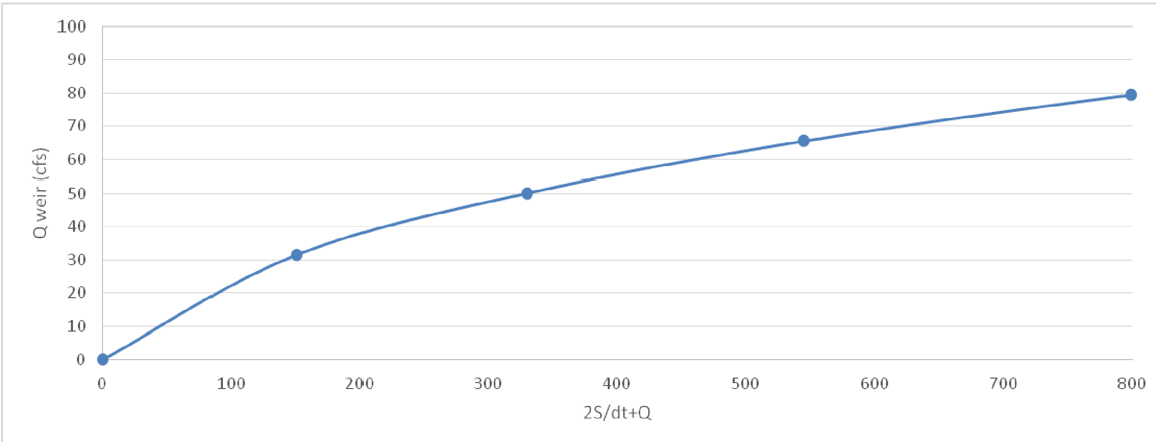
$$\mathrm{S(h = 3ft) = 30000 \times 3 + 6000 \times 3^2 = 144000\ ft^3}$$

$$Q_{weir} = C_w L\, h^{3/2} = 3.5 \times 9\, h^{3/2} \rightarrow Q_{weir(h=3\,ft)} = 31.5\,(3)^{3/2} = 65.522\, cfs$$

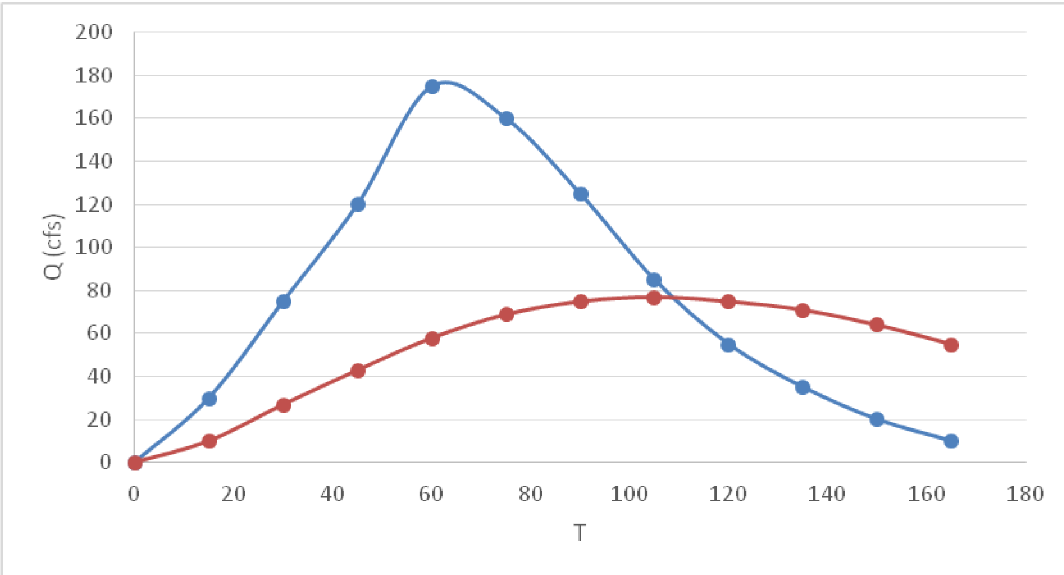
$$\frac{2S}{\Delta t} + Q = 2 \times \frac{144000\mathrm{ft}^3}{10 \times 60\mathrm{s}} + 65.522\ \mathrm{cfs} = 545.52$$

h	Area (ft2)	Storage (ft3)	Q weir (cfs)	2S/dt+Q
0	30000	0	0	0
1	42000	36000	31.5	151.5

2	54000	84000	50.003133	330.0031
3	66000	144000	65.52264	545.5226
4	78000	216000	79.375026	799.375
5	90000	300000	92.106559	1092.107
6	102000	396000	104.01071	1424.011
7	114000	504000	115.26813	1795.268
8	126000	624000	126	2206
9	138000	756000	136.29258	2656.293
10	150000	900000	146.21005	3146.21
11	162000	1056000	155.80175	3675.802
12	174000	1224000	165.10671	4245.107
13	186000	1404000	174.15641	4854.156
14	198000	1596000	182.97675	5502.977
15	210000	1800000	191.58936	6191.589
16	222000	2016000	200.01253	6920.013
17	234000	2244000	208.2619	7688.262
18	246000	2484000	216.35099	8496.351
19	258000	2736000	224.29157	9344.292
20	270000	3000000	232.09398	10232.09
21	282000	3276000	239.76737	11159.77
22	294000	3564000	247.31987	12127.32
23	306000	3864000	254.75875	13134.76
24	318000	4176000	262.09056	14182.09
25	330000	4500000	269.32121	15269.32
26	342000	4836000	276.45606	16396.46
27	354000	5184000	283.5	17563.5
28	366000	5544000	290.45749	18770.46
29	378000	5916000	297.33262	20017.33
30	390000	6300000	304.12916	21304.13
31	402000	6696000	310.85058	22630.85
32	414000	7104000	317.5001	23997.5
33	426000	7524000	324.08071	25404.08
34	438000	7956000	330.59517	26850.6
35	450000	8400000	337.04606	28337.05
36	462000	8856000	343.43579	29863.44
37	474000	9324000	349.76663	31429.77
38	486000	9804000	356.04068	33036.04
39	498000	10296000	362.25992	34682.26
40	510000	10800000	368.42624	36368.43



Time (min)	In (cfs)	In + In+1 (cfs)	2Sn/dt-Qn	2Sn+1/dt+Qn+1	Qn+1 (cfs)	Qn (cfs)
0	0	30	0	30	10	0
15	30	105	10	115	27	10
30	75	195	61	260	43	27
45	120	295	174	425	58	43
60	175	335	309	606.825	69	58
75	160	285	468.825	725.013125	75	69
90	125	210	575.0131	759.3371406	77	75
105	85	140	605.3371	721.0868551	75	77
120	55	90	571.0869	635.7053409	71	75
135	35	55	493.7053	521.7274404	64	71
150	20	30	393.7274	391.2978823	55	64
165	10	10	281.2979	250.6505412	43	55
						43



Q (cfs)
200
180
160
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
T