CV2020 2022/2023 Sem 1

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① a) $S_0 = 0.0001$

$n = 0.016$

$$Q_I = Q_{III} = \frac{1}{n} A \, Rh^{2/3} \, S_0^{1/2}$$

$$= \frac{\sqrt{0.0001}}{0.016} \left(\tfrac{1}{2}\right)(1.7\sqrt{3})(1.7) + \left[\frac{\left(\tfrac{1}{2}\right)(1.7\sqrt{3})(1.7)}{3.4} \right]^{2/3}$$

$$= 1.275 \ m^3$$

$$Q_{II} = \frac{1}{n} A \, Rh^{2/3} \, S_0^{1/2}$$

$$= \frac{\sqrt{0.0001}}{0.016} (8)(1.7) \left[\frac{8(1.7)}{8} \right]^{2/3}$$

$$= 12.107 \ m^3/s$$

$$\text{Total } Q = Q_I + Q_{II} + Q_{III}$$

$$= 1.275 + 12.107 + 1.275$$

$$= 14.657 \ m^3/s$$

$$\text{Contribution of mid-channel} = \frac{Q_{II}}{\text{Total } Q} \times 100\%$$

$$= \frac{12.107}{14.657} \times 100\%$$

$$= 82.6\%$$

b) (i) $Q \sim \frac{1}{n}$

$$Q_I = Q_{II} = \frac{n_{old}}{n_{new}} \times Q_{old}$$

$$= \frac{0.016}{0.02} \times (1.275)$$

$$= 1.020 \ m^3/s$$

$$Q_{II} = \frac{n_{old}}{n_{new}} \times Q_{old}$$

$$= \frac{0.016}{0.018} (12.107)$$

$$= 10.762 \ m^3/s$$

$$\text{Total } Q_{new} = Q_I + Q_{II} + Q_{III}$$

$$= 1.020 + 10.762 + 1.020$$

$$= 12.712 \ m^3/s$$

$$\frac{\Delta Q}{Q_{old}} = \frac{12.712 - 14.657}{1.657} \times 100\%$$

$$= -13.35\%$$

// shown

(ii) From (b)(i)

$Q_I = Q_{III} = 1.020 \ m^3/s$

From (a)

$Q_{II} = 12.107 \ m^3/s$

$$\text{Total } Q = Q_I + Q_{II} + Q_{III}$$
$$= 1.020 + 12.107 + 1.020$$
$$= 14.147 \ m^3/s$$

$$\frac{\Delta Q}{Q_{old}} = \frac{14.147 - 14.657}{1.657} \times 100\%$$
$$= -3.48\%$$

which is less than 5% lower

// shown

c) (i) A-A to B-B → Hump

$E_A = E_B + \Delta z + \text{Loss}$

$E_A = E_B + \Delta hump + L_{AB}$

$E_B = E_A - \Delta hump - L_{AB}$

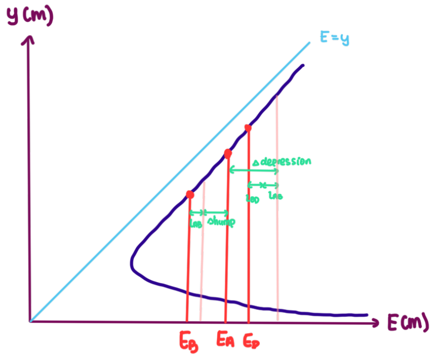
B-B to D-D → Depression

$E_B = E_D - \Delta z + \text{Loss}$

E_A - ~~$\Delta hump$~~ $- L_{AB} = E_D - ($~~$\Delta hump$~~ $+ \Delta depression) + L_{BD}$

$E_D = E_A + \Delta depression - L_{AB} - L_{BD}$

(ii)

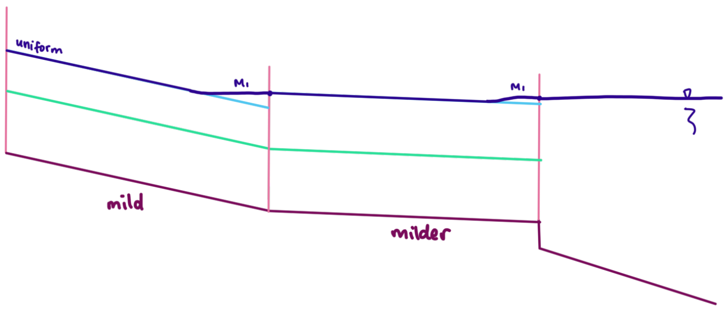


NOTE:

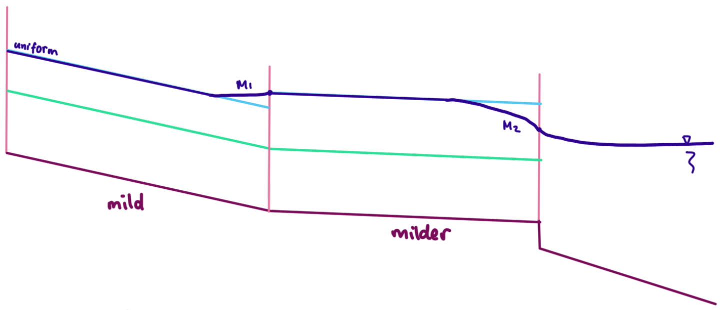
- bed
- y_0
- y_c
- water surface

② (i) mild to milder

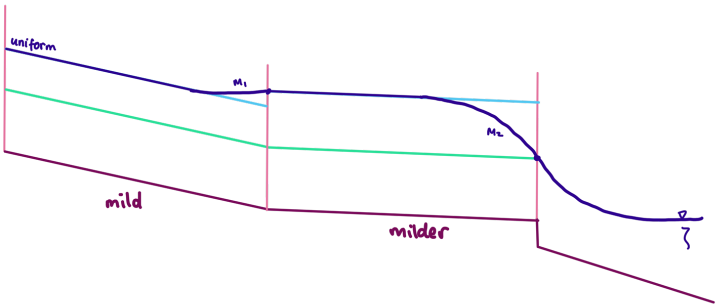
- $y > y_0$ and $y > y_c$



- $y_c < y < y_0$

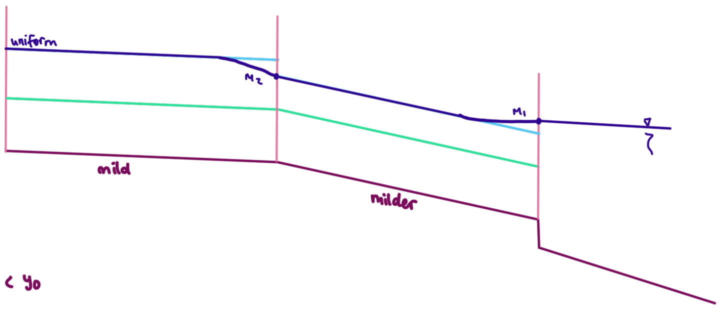


- $y < y_0$ and $y < y_c$

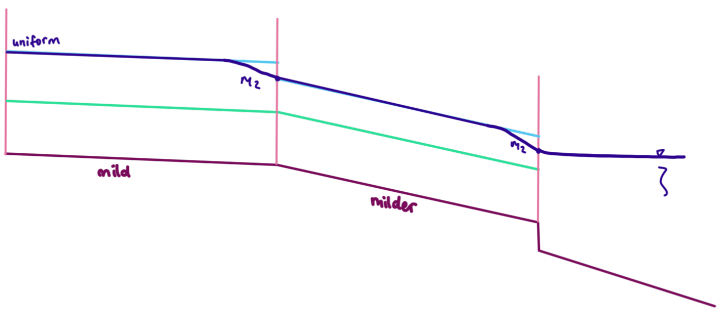


(ii) mild to less mild

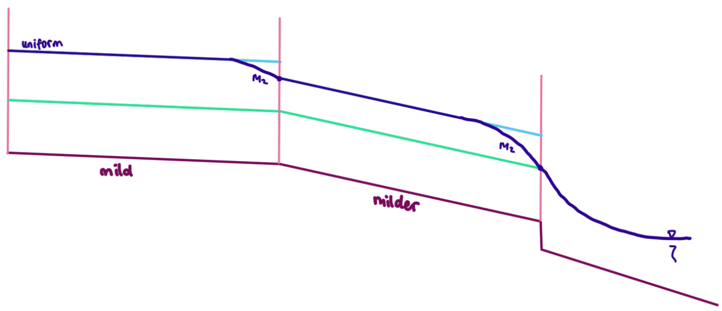
- $y > y_0$ and $y > y_c$



- $y_c < y < y_0$

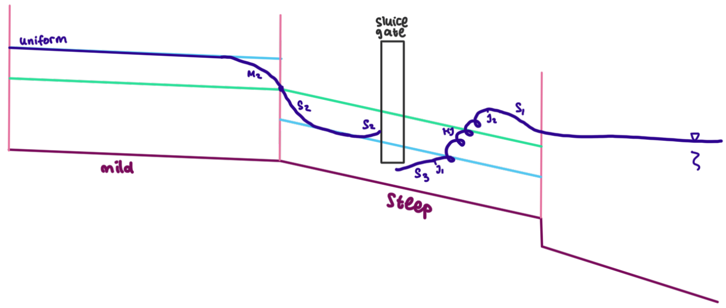


- $y < y_0$ and $y < y_c$

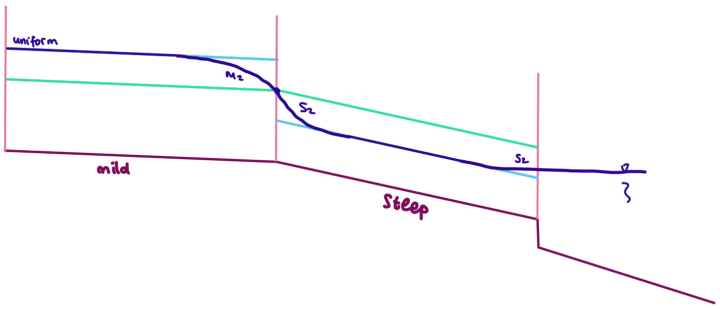


(ii) mild to steep

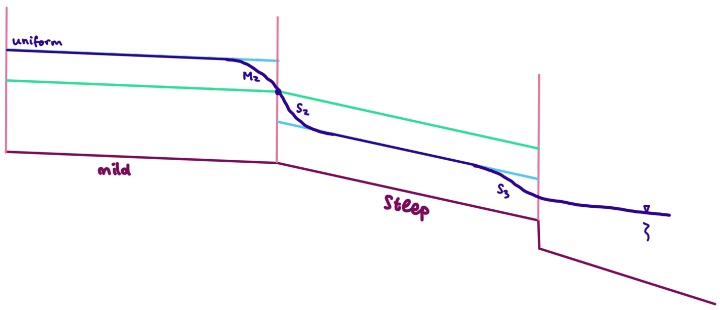
- $y > y_0$ and $y > y_c$



- $y_0 < y < y_c$



- $y < y_0$ and $y < y_c$



(3) a) Effective rain $= [(125-75)+(175-75)+(225-75)]\left(\frac{15}{60}\right)$

$= 75$ mm

Direct Runoff Volume = (Effective rain depth) × (Catchment Area)

$= (75 \; 10^{-3}) \times (500 \; 10^{6})$

$= 37{,}500{,}000 \text{ m}^3$

$= 37.5 \times 10^{6} \text{ m}^3$

b) $f_0 = 55$ mm/hr

$f_c = 5$ mm/hr

$k = 0.4$/hr

Horton's Equation : $f = f_c + (f_0 - f_c)e^{-kt}$

$f = 5 + 50e^{-0.4t}$

(i) $f_2 = 5 + 50e^{-0.8} = 27.47$ mm/hr

$f_6 = 5 + 50e^{-2.4} = 9.54$ mm/hr

(ii) Total depth = Area under infiltration curve

$= \int_0^6 (5 + 50e^{-0.4t})\,dt$

$= \left[5t - 125e^{-0.4t}\right]_0^6$

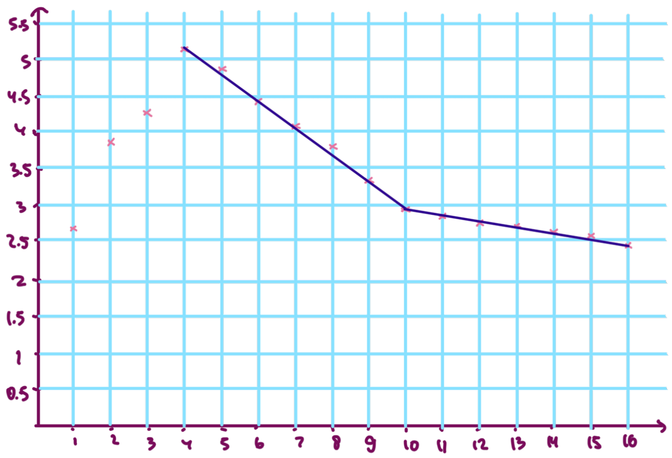
$= 30 - 125e^{-2.4} - 0 + 125$

$= 143.66$ mm

C) (i) Recession Equation : $Q_t = Q_0 e^{-\alpha t}$

$\ln Q_t = \ln Q_0 - \alpha t$

Time	ln Q
1	2.67
2	3.82
3	4.26
4	5.18
5	4.80
6	4.43
7	4.09
8	3.77
9	3.33
10	2.94
11	2.83
12	2.74
13	2.67
14	2.60
15	2.53
16	2.44



$\alpha = \frac{2.94 - 2.44}{16 - 10}$

$= 0.0837$

at $t = 10$

$Q_{10} = Q_0 e^{-\alpha t}$

$19 = Q_0 e^{-0.0837(10)}$

$Q_0 = 43.871 \text{ m}^3/\text{s}$

at $t = 16$

$Q_{16} = Q_0 e^{-\alpha t}$

$11.5 = Q_0 e^{-0.0837(16)}$

$Q_0 = 43.871 \text{ m}^3/\text{s}$

$\therefore Q_0 = 43.871 \text{ m}^3/\text{s}$

Recession Equation : $Q_t = 43.871 e^{-0.0837t}$

(ii)

$$\frac{Q - Q_1}{Q_{10} - Q_1} = \frac{t - t_1}{t_{10} - t_1}$$

$$\frac{Q - 14.5}{19 - 14.5} = \frac{t - 1}{10 - 1}$$

$$\frac{Q - 14.5}{4.5} = \frac{t - 1}{9}$$ (2)

$$Q = \frac{t}{2} + 14$$

Time	Baseflow
1	14.5
2	15
3	15.5
4	16
5	16.5
6	17
7	17.5
8	18
9	18.5
10	19
11	17
12	15.5
13	14.5
14	13.5
15	12.5
16	11.5

(4) a) $Q_i = 60\ m^3/s$

$K = 1.6$ days

$x = 0.2$

$I_i = 60\ m^3/s$

$I_f = 30\ m^3/s$

$\Delta t = 1$ day

$$C_0 = \frac{-Kx + 0.5\Delta t}{K - Kx + 0.5\Delta t} = \frac{-1.6(0.2) + 0.5(1)}{1.6 - 1.6(0.2) + 0.5(1)} = \frac{9}{89}$$

$$C_1 = \frac{Kx + 0.5\Delta t}{K - Kx + 0.5\Delta t} = \frac{1.6(0.2) + 0.5(1)}{1.6 - 1.6(0.2) + 0.5(1)} = \frac{41}{89}$$

$$C_2 = \frac{K - Kx - 0.5\Delta t}{K - Kx + 0.5\Delta t} = \frac{1.6 - 1.6(0.2) - 0.5(1)}{1.6 - 1.6(0.2) + 0.5(1)} = \frac{39}{89}$$

$$Q_2 = C_0 I_2 + C_1 I_1 + C_2 Q_1$$

$$= \frac{8I_2 + 41 I_1 + 39 Q_1}{89}$$

$$= \frac{8(30) + 41(60) + 39(60)}{89}$$

$$= 56.63\ m^3/s$$

b) (i)

Time	S-curve	Lagged	Subtracted	3-hr UH
0	0	0	0	0
1	55	0	55	27.5
2	145	0	145	72.5
3	260	0	260	130
4	335	55	280	140
5	365	145	220	110
6	385	260	125	62.5
7	385	335	50	25
8	385	365	20	10
9	385	385	0	0

(ii) $i_{1.5} = \frac{\text{depth}}{\text{duration}} = \frac{10}{1.5}$ mm/hr

$Q_e = 385 \ m^3/s$

$$\text{Area} = \frac{Q_e}{i_{1.5}}$$

$$= \frac{385}{\frac{10}{1.5} \cdot \frac{10^{-3}}{3600}}$$

$$= 207{,}900{,}000 \ m^2$$

$$= 207.9 \ km^2$$

c)

Time	UH	Q_1	Q_2	Q_3	Q_4	Total
1	$\frac{2}{12}$	$\frac{2}{12}$	0	0	0	$\frac{1}{6}$
2	$\frac{4}{12}$	$\frac{4}{12}$	$\frac{2}{12}$	0	0	$\frac{1}{2}$
3	$\frac{3}{12}$	$\frac{3}{12}$	$\frac{4}{12}$	$\frac{8}{12}$	0	$\frac{5}{4}$
4	$\frac{2}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{16}{12}$	$\frac{4}{12}$	$\frac{25}{12}$
5	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{12}{12}$	$\frac{8}{12}$	$\frac{23}{12}$
6	0	0	$\frac{1}{12}$	$\frac{8}{12}$	$\frac{6}{12}$	$\frac{5}{4}$
7	0	0	0	$\frac{4}{12}$	$\frac{4}{12}$	$\frac{2}{3}$
8	0	0	0	0	$\frac{2}{12}$	$\frac{1}{6}$
9	0	0	0	0	0	0