CV2020 2021/2022 Sem 1

By: Margaretha Eraudi Siahaan

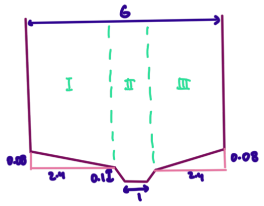
① a) $Q = \frac{1}{n} A R_h^{2/3} S_o^{1/2}$

$$12 = \frac{1}{0.018}(6)(y_o)\left[\frac{6y_o}{6+2y_o}\right]^{2/3}\sqrt{0.001}$$

$y_o = 1.2415\ m$

$y_o = 1242\ mm$

b)



$Q = 12 m^3/s$
$n = 0.018$
$S_o = 0.001$

$$Q = \frac{1}{n} A R_h^{2/3} S_o^{1/2}$$

$$12 = \frac{1}{0.018}\left[(6)(y_o-0.1)+(1+0.1)(0.1)-2(\tfrac{1}{2})(2.4)(0.08)\right]\left[\frac{6(y_o-0.1)+(1+0.1)(0.1)-2(\frac{1}{2})(2.4)(0.08)}{2(y_o-0.18)+1+2(0.1\sqrt{2})+2\sqrt{2.4^2+0.08^2}}\right]^{2/3}\sqrt{0.001}$$

$$\frac{2.16}{\sqrt{0.1}} = (6y_o - 0.682)^{5/3}(2y_o + 5.7255)^{-2/3}$$

$y_o = 1.352\ m$

// verified

c) The U-drain in part (b) so that during dry season when the volume of water flowing in the channel is relatively small, the water will be concentrated in the middle trapezoidal channel that is lower in depth which allow the water to flow faster

d) Chocking condition will occur at critical depth

$$y_c = \sqrt[3]{\frac{q^2}{g}}$$

$$= \sqrt[3]{\frac{(12)^2}{9.81(6)^2}}$$

$= 0.7415\ m$

Hump $\rightarrow$ $E_1 = E_2 + \Delta z$

$$y_1 + \frac{V_1^2}{2g} = \frac{3}{2}y_c + \Delta z$$

$$1.2415 + \frac{12^2}{2(9.81)(6)^2(1.2415)^2} = \frac{3}{2}(0.7415) + \Delta z$$

$\Delta z = 0.2615\ m$

② a) - Reach A-B

$Q = \frac{1}{n} A R_h^{2/3} S_0^{1/2}$

$1300 = \frac{1}{0.03}(1000y)\left[\frac{1000y}{1000+2y}\right]^{2/3}\sqrt{0.0001}$

$y = 2.267\,m$

$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{1300^2}{(9.81)(1000)^2}} = 0.556\,m$

$\frac{B}{y} = \frac{1000}{2.267} = 441.1 > 10 \rightarrow$ yes

- Reach B-C

$Q = \frac{1}{n} A R_h^{2/3} S_0^{1/2}$

$650 = \frac{1}{0.02}(500y)\left[\frac{500y}{500+2y}\right]^{2/3}\sqrt{0.0001}$

$y = 1.779\,m$

$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{650^2}{(9.81)(500)^2}} = 0.556\,m$

$\frac{B}{y} = \frac{500}{1.779} = 281.06 > 10 \rightarrow$ yes

- Reach C-D

$Q = \frac{1}{n} A R_h^{2/3} S_0^{1/2}$

$650 = \frac{1}{0.02}(250y)\left[\frac{250y}{250+2y}\right]^{2/3}\sqrt{0.002}$

$y = 1.099\,m$

$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{650^2}{(9.81)(250)^2}} = 0.883\,m$

$\frac{B}{y} = \frac{250}{1.099} = 227.5 > 10 \rightarrow$ yes

- Reach D-E

$Q = \frac{1}{n} A R_h^{2/3} S_0^{1/2}$

$1100 = \frac{1}{0.02}(250y)\left[\frac{250y}{250+2y}\right]^{2/3}\sqrt{-0.0002}$

→ can't be determined because $S_0 < 0$

$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{1100^2}{(9.81)(250)^2}} = 1.254\,m$

$\frac{B}{y} = \frac{250}{3.024} = 82.7 > 10 \rightarrow$ yes

- Reach A-B

$Q = \frac{1}{n} A R_h^{2/3} S_0^{1/2}$

$1100 = \frac{1}{0.02}(250y)\left[\frac{250y}{250+2y}\right]^{2/3}\sqrt{0.002}$

$y = 1.508\,m$

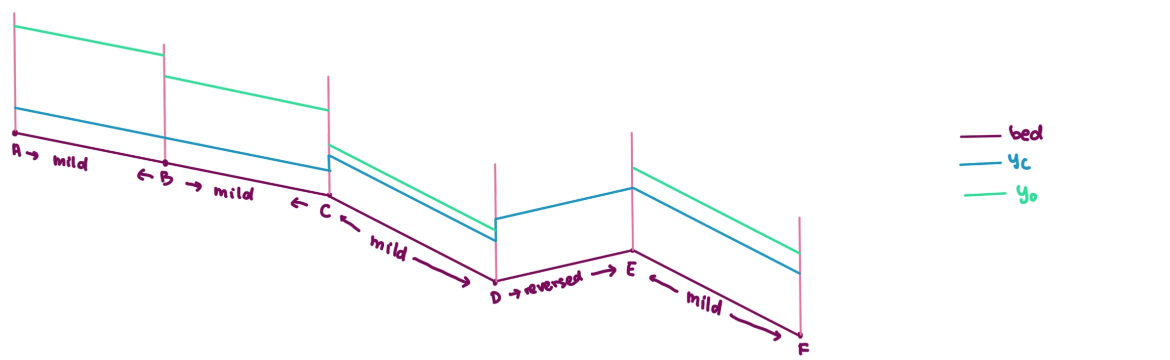
$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{1100^2}{(9.81)(250)^2}} = 1.254\,m$

$\frac{B}{y} = \frac{250}{1.508} = 165.78 > 0 \rightarrow$ yes

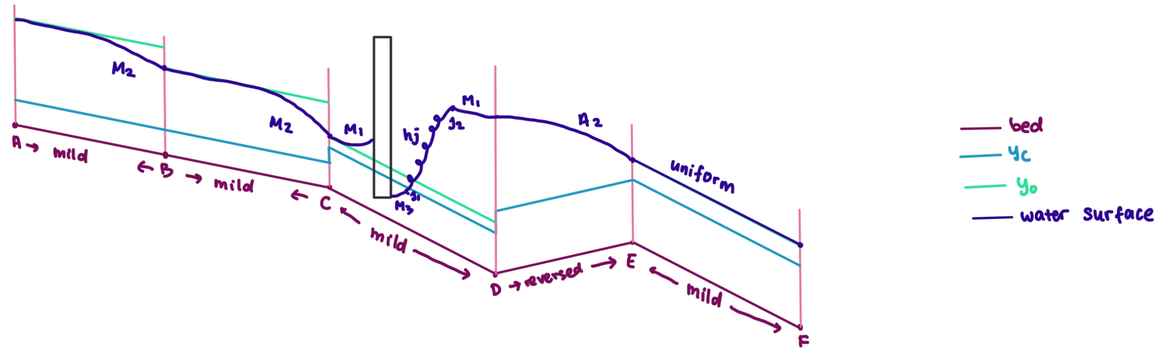
Reach	y_0 (m)	y_c (m)
A-B	2.267	0.556
B-C	1.779	0.556
C-D	1.099	0.883
D-E	can't be determined	1.254
E-F	1.508	1.254

⇒ It is reasonable to use y as R_h because the B is so large such that $\frac{B}{y} >> 10$

b)



c)



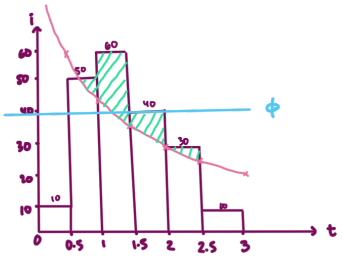
③ a) at min 10 - 30

$$\text{Intensity} = \frac{\text{depth}}{\text{duration}}$$

$$= \frac{(180+140)(0.2)}{20/60}$$

$$= 192 \text{ mm/hr}$$

b)



(i) $f(t) = 10 + \frac{50}{t+0.5}$

$f(0) = 110$

$f(0.5) = 60$

$f(1) = 43.33$

$f(1.5) = 35$

$f(2) = 30$

$f(2.5) = 26.67$

$f(3) = 24.29$

$50 = 10 + \frac{50}{t+0.5}$

$t = 0.75$

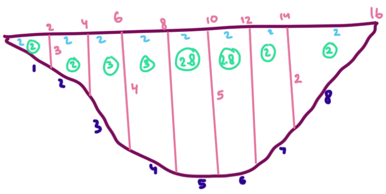
$$\text{Total runoff depth} = \frac{1}{2}(0.25)(50-43.33) + \frac{60-43.33+60-35}{2}(0.5) + \frac{40-35+40-30}{2}(0.5) + \frac{1}{2}(30-26.67)(0.5)$$

$$= 15.83 \text{ mm}$$

(ii) $15.83 = \left[(50-\phi) + (60-\phi) + (40-\phi)\right](0.5)$

$$\phi = 39.44 \text{ mm/hr}$$

c)



* depth of current meter = 0.6 × water depth

1) $A = \frac{1}{2}(2)(3) = 3$

2) $A = (2)(3) = 6$

3) $A = 2(4) = 8$

4) $A = 2(4) = 8$

5) $A = 2(5) = 10$

6) $A = 2(5) = 10$

7) $A = 2(2) = 4$

8) $A = \frac{1}{2}(2)(2) = 2$ +

A total $= 51$

$Q = 2(3) = 6$

$Q = 2(6) = 12$

$Q = 3(8) = 24$

$Q = 3(8) = 24$

$Q = 2.8(10) = 28$

$Q = 2.8(10) = 28$

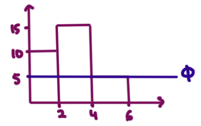
$Q = 2(4) = 8$

$Q = 2(2) = 4$ +

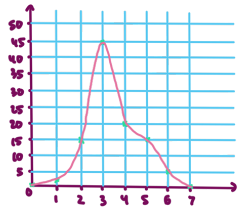
Q total $= 134 \text{ m}^3/\text{s}$

$$V_{avg} = \frac{Q_{total}}{A_{total}} = 2.627 \text{ m/s}$$

4 a)



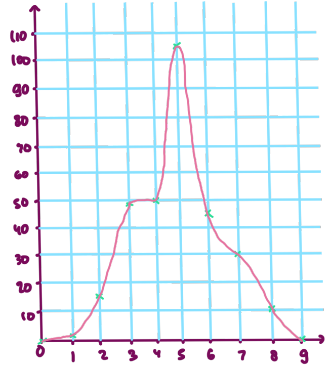
duration : 4 hr



(i)

Time	0-2	2-4	Total
0	0	0	0
1	2	0	2
2	15	0	15
3	45	4	49
4	20	30	50
5	15	90	105
6	5	40	45
7	0	30	30
8	0	10	10
9	0	0	0

$Q_{total} = 306\ m^3/s$



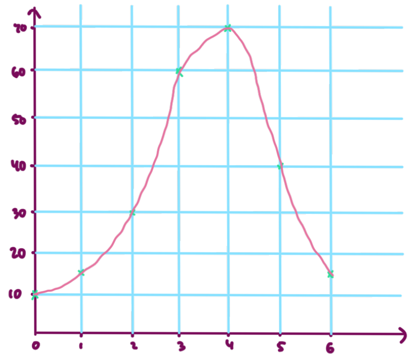
(ii) Total volume = $306 \times 3600 = 1,101,600\ m^3$

Rainfall depth = $(5+10)(2) = 30\ mm = 0.03\,m$

Area = $\frac{Vol}{depth} = \frac{1,101,600}{0.03} = 36,720,000\ m^2 = 36.72\ km^2$

b)

Time	I_t	$\frac{\Delta S_t}{\Delta t} - Q_t$	$\frac{\Delta S_{t+1}}{\Delta t} + Q_{t+1}$	Q_t
0	10	10	30	10
1	20	10	40	15
2	40	10	70	30
3	80	10	130	60
4	60	10	150	70
5	20	10	90	40
6	10	10	40	15



S	Q	$\frac{2S}{\Delta t} + Q$
18	0	10
180	90	190

c) $S = K[xI + (1-x)Q]$

$$\frac{I_1 + I_2}{2} - \frac{Q_1 + Q_2}{2} = \frac{K[xI_2 + (1-x)Q_2 - xI_1 - (1-x)Q_1]}{\Delta t}$$

$$\frac{I_1}{2} + \frac{I_2}{2} - \frac{Q_1}{2} - \frac{Q_2}{2} = \frac{Kx}{\Delta t} I_2 + \frac{K(1-x)}{\Delta t} Q_2 - \frac{Kx}{\Delta t} I_1 - \frac{K(1-x)}{\Delta t} Q_1$$

$$\left(\frac{K(1-x)}{\Delta t} + \frac{1}{2}\right) Q_2 = \left(-\frac{Kx}{\Delta t} + \frac{1}{2}\right) I_2 + \left(\frac{Kx}{\Delta t} + \frac{1}{2}\right) I_1 + \left(-\frac{1}{2} + \frac{K(1-x)}{\Delta t}\right) Q_1$$

$$\frac{2K(1-x)+\Delta t}{\cancel{2\Delta t}} \cdot Q_2 = \frac{-2Kx+\Delta t}{\cancel{2\Delta t}} \cdot I_2 + \frac{2Kx+\Delta t}{\cancel{2\Delta t}} \cdot I_1 + \frac{2K(1-x)-\Delta t}{\cancel{2\Delta t}} \cdot Q_1$$

$$Q_2 = \frac{-2Kx+\Delta t}{2K(1-x)+\Delta t} \cdot I_2 + \frac{2Kx+\Delta t}{2K(1-x)+\Delta t} \cdot I_1 + \frac{2K(1-x)-\Delta t}{2K(1-x)+\Delta t} \cdot Q_1$$

$\therefore C_0 = \frac{-2Kx+\Delta t}{2K(1-x)+\Delta t}$ $\quad C_1 = \frac{2Kx+\Delta t}{2K(1-x)+\Delta t}$ $\quad C_2 = \frac{2K(1-x)-\Delta t}{2K(1-x)+\Delta t}$