

17/18 Sem1 CV3014 Solution

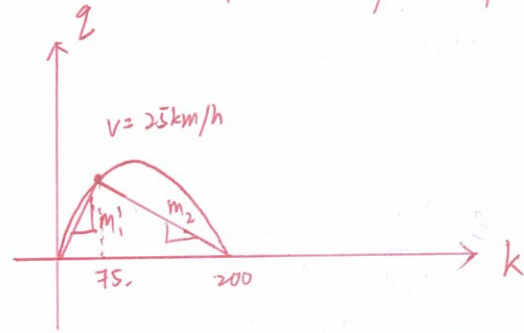
1(a) Given $V_f = 40 \text{ km/h}$ $k_j = 200 \text{ veh/km}$

$$q_{\max} = \left(\frac{V_f}{2}\right) \left(\frac{k_j}{2}\right)$$

$$= \frac{40 \times 200}{2}$$

$$= 2000 \text{ veh/h}$$

1.(b) Answer provided by school is 300m.



Greenshiield's model

$$V = V_f \left(1 - \frac{k}{k_j}\right)$$

$$q = V_f \left(k - \frac{k^2}{k_j}\right)$$

when $v=25$

$$25 = 40 \left(1 - \frac{k}{200}\right)$$

$$k = 75 \text{ veh/km.}$$

$$q = 40 \left(75 - \frac{75^2}{200}\right)$$

$$= 1875 \text{ veh/h}$$

$$m_1 = \frac{1875}{75}$$

$$= 25 \text{ km/h.}$$

$$m_2 = \frac{1875}{200-75}$$

$$= 15 \text{ km/h.}$$

$$185 \times 25 \text{ km/h}$$

$$= 125 \text{ m.}$$

$$185 \times 15 \text{ km/h}$$

$$= 75 \text{ m.}$$

$$125 \text{ m} - 75 \text{ m} = 50 \text{ m.}$$

This is what I did in the exam, but I am not confident with it. I had tried my best to recap but there is limited information in slides.

Kindly let me know if you know the correct solution.

2(a) Given $A = |-4-2|$

$$= 6$$

$$S = 120 \text{ m}$$

$$h_1 = 1.21 \text{ m}$$

$$h_2 = 0.25 \text{ m}$$

Find L .

Assume $L \gg S$

$$L_{\min} = \frac{AS^2}{200 (\sqrt{h_1} + \sqrt{h_2})^2}$$

$$= \frac{6 (120)^2}{200 (\sqrt{1.21} + \sqrt{0.25})^2}$$

$$= 270 \text{ m.} \gg 120 \text{ m}$$

\therefore Assumption is correct!

2(b) Given $L = 300 \text{ m}$

$$r = \frac{-0.04 - 0.02}{300}$$

$$= -2 \times 10^{-4}$$

$$g_i = 0.02$$

$$y = y_0 + g_i x + \frac{rx^2}{2}$$

$$\frac{dy}{dx} = g_i + rx$$

$$\text{let } \frac{dy}{dx} = 0$$

$$0.02 - 2 \times 10^{-4} x = 0$$

$$x = 100 \text{ m.}$$

When $x = 100 \text{ m}$,

$$y = 60 + 0.02(100) - \frac{2 \times 10^{-4}}{2} (100)^2$$

$$= 61 \text{ m.}$$

\therefore Answ = 101 + 10, 61m.

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$$3. V_{bus} = -0.2(T + P_B)$$

$$V_{car} = -0.2(T + P_C)$$

$$T = 30 + 2 \times 10^{-7} q^2$$

$$(a) P_B = P_C - 5$$

$$\begin{aligned} \text{Percentage of people choose bus} &= \frac{e^{u_{bus}}}{e^{u_{car}} + e^{u_{bus}}} \\ &= \frac{e^{-0.2(T + P_C - 5)}}{e^{-0.2(T + P_C)} + e^{-0.2(T + P_C - 5)}} \\ &= \frac{1}{1 + e} \end{aligned}$$

$$Q_{car} = \frac{1}{1+e} (20,000)$$

$$= 5379.$$

$$Q_{bus} = 20,000 - 5379$$

$$= 14621_{rr}.$$

$$(b) (i) \text{ let } 20,000 T = 8.6 \times 10^5 \quad P_B = 2$$

$$T = 43$$

$$30 + 2 \times 10^{-7} q^2 = 43$$

$$q = 8062.$$

$$\text{number of car} = 8062 - 250$$

$$= 7812$$

$$\text{number of people choose car} = 7812 \quad (\because \text{sharing is not practised}).$$

$$\begin{aligned} \frac{7812}{20,000} &= \frac{e^{u_{car}}}{e^{u_{car}} + e^{u_{bus}}} \\ \frac{7812}{20,000} &= \frac{e^{-0.2(T + P_C)}}{e^{-0.2(T + P_C)} + e^{-0.2(T + 2)}} \end{aligned}$$

$$\frac{7812}{20,000} = \frac{e^{-0.2P_C}}{e^{-0.2P_C} + e^{-0.4}}$$

Use calculator,

$$P_C = 4.224.$$

$$(b) (ii) Q_B = 13,000$$

$$\frac{13,000}{20,000} = \frac{e^{u_B}}{e^{u_B} + e^{u_C}}$$

$$\frac{13}{20} = \frac{e^{-0.2(T + P_B)}}{e^{-0.2(T + P_B)} + e^{-0.2(T + P_C)}}$$

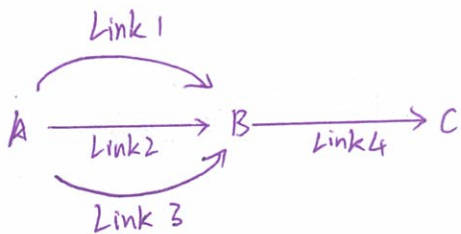
$$\frac{13}{20} = \frac{e^{-0.4}}{e^{-0.4} + e^{-0.2P_C}}$$

Use calculator,

$$P_C = 5.095$$

$$\therefore 4.224 \leq P_C \leq 5.095$$

4.



Given

$$t_1 = 14 + 2x_1$$

$$t_2 = 12 + 2x_2$$

$$t_3 = 10 + x_3$$

$$t_4 = 8 + x_4$$

(a) $x_2 = 3$

① $t_1 = t_2$
 $14 + 2x_1 = 12 + 2(3)$
 $x_1 = 2$

② $t_3 = t_2$
 $10 + x_3 = 12 + 2(3)$
 $x_3 = 8$

③ $x_4 = x_1 + x_2 + x_3$
 $= 2 + 3 + 8$
 $= 13$

$\therefore D = 13$

(b) $D = 18 - 0.5t$

$$\begin{cases} t_1 = t_2 \\ t_3 = t_2 \\ D = 18 - 0.5t \quad (D = x_4, t = t_1 + t_4) \\ x_4 = x_1 + x_2 + x_3 \end{cases}$$

$$\Rightarrow \begin{cases} x_1 - x_2 = -1 & -11) \\ 2x_2 - x_3 = -2 & -12) \\ x_1 + 3/2 x_4 = 7 & -13) \\ x_1 + x_2 + x_3 - x_4 = 0 & -14) \end{cases}$$

(2) + (4)

$$\Rightarrow \begin{cases} x_1 - x_2 = -1 \\ x_1 + 3x_2 - x_4 = -2 \\ x_1 + 3/2 x_4 = 7 \end{cases}$$

Use calculator,

$$(x_1, x_2, x_3, x_4) = \left(-\frac{1}{14}, \frac{13}{14}, \frac{27}{7}, \frac{33}{7} \right)$$

negative, means none use link 1.

$$\begin{cases} t_2 = t_3 \\ D = 18 - 0.5t \quad (D = x_4, t = x_2 + x_4) \\ x_4 = x_2 + x_3 \end{cases}$$

$$\begin{cases} 2x_2 - x_3 = -2 \\ x_2 + 3/2 x_4 = 8 \\ x_2 + x_3 - x_4 = 0 \end{cases}$$

$\therefore D = \frac{52}{11}$

$$\Rightarrow (x_1, x_2, x_3, x_4) = \left(0, \frac{10}{11}, \frac{42}{11}, \frac{52}{11} \right)$$

5(a) Formula: $A = \frac{W}{4} (Y_1 + Y_r) + \frac{C}{2} (X_1 + X_r)$

Area

151+00
 $Cut = \frac{12}{4} (1.6 + 2.5) + \frac{2.1}{2} (9.2 + 11)$
 $= 33.5 \text{ m}^2$

Volume

$$Cut = 30 \left(\frac{33.51 + 10.86}{2} \right)$$

$$= 665.55 \text{ m}^3$$

151+30
 $Cut = \frac{12}{4} (0 + 1.4) + \frac{0.9}{2} (6.0 + 8.8)$
 $= 10.86 \text{ m}^2$

$$Cut = 40 \left(\frac{10.86 + 1.2}{2} \right)$$

$$= 241.2 \text{ m}^2$$

$$Fill = \frac{1}{3} (40) (4.5)$$

$$= 60 \text{ m}^3$$

151+70
 $Cut = \frac{1}{2} \left(\frac{12}{2} \right) (0.4)$
 $= 1.2 \text{ m}^2$

$$Fill = \frac{1}{2} \left(\frac{12}{2} \right) (1.5)$$

$$= 4.5 \text{ m}^2$$

$$Cut = \frac{1}{3} (1.2) (30)$$

$$= 12 \text{ m}^3$$

152+00
 $Fill = \frac{12}{4} (3.0 + 0) + \frac{1.1}{2} (12 + 6)$
 $= 22.5 \text{ m}^2$

$$Fill = 30 \left(\frac{4.5 + 2.5}{2} \right)$$

$$= 405 \text{ m}^3$$

Total Cut = $665.35 + 241.2 + 12 = 918.75 \text{ m}^3$

Total fill = $405 + 60 = 465 \text{ m}^3$

5(b) Refer to lecture note.

Module 6: Pavement Design

or Consult Prof Neng Yik Diew 😊

$$b. SN_1 = 0.45 \times 50 \\ = 22.5$$

$$SN_2 = 22.5 + 0.25(1.20)(130) \\ = 61.5$$

$$SN_3 = 61.5 + 0.2(1.10)(150) \\ = 94.5$$

$$\text{Option 2: } (0.25)(1.2)D_2 = 94.5 - 22.5$$

$$D_2 = 240 \text{ mm} < (130 + 150) \text{ mm}$$

$$\text{Option 3: } (0.12)(0.6)D_3 = 94.5 - 22.5$$

$$D_3 = 1000 \text{ mm} > (130 + 150) \text{ mm.}$$

Remarks: I am not sure how to score full marks for the final part. I think it should be something related to cost, availability, space etc. Hope this help! Thank You.

Provided By.

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