FINAL EXAMINATION
SEMESTER I, SESSION 2017/2018

COURSE CODE	:	SKAA 3842 / SAB 3842
COURSE	:	TRAFFIC ENGINEERING
PROGRAMME	:	SKAW / SAW
DURATION	:	2 HOURS
DATE	:	JANUARY, 2018

INSTRUCTION TO CANDIDATES:

1. ANSWER ALL FOUR (4) QUESTIONS FROM FIVE (5) QUESTIONS.
2. WRITE YOUR NAME, SECTION AND LECTURER'S NAME ON THE FRONT PAGE OF EVERY ANSWER'S BOOKLET.
3. YOU ARE NOT ALLOWED TO REFER TO ANY NOTES.

WARNING!

Students caught copying/cheating during the examination will be liable for disciplinary actions and the faculty may recommend the student to be expelled from the study.

This examination question consists of (8) printed pages only.

Q1. (a) Briefly distinguish between:

(i) sight distance, stopping sight distance and passing sight distance; and

(ii) reaction time and perception time.

(10 marks)

(b) Explain in what way the drivers' perception-reaction time, speed of vehicle (or deceleration and acceleration rates), friction between tyre and road surface, and gradient of the road section affect sight distance.

(15 marks)

(25 marks)

Q2. (a) Table Q2(a) tabulates travel times (in seconds) of 6 vehicles as they tranversed a 3 km segment of a highway in Yong Peng, Johor.

Table Q2 (a)

Vehicle	1	2	3	4	5	6
Travel Time (sec)	150	144	160	125	135	115

i) Determine the time mean speed and space mean speed for these data.
ii) Clearly explain why space mean speed is always lower than time mean speed.
iii) Determine the mean running speed of vehicles on this segment if the average delay of each vehicles are 35, 20, 35, 15, 18 and 10 seconds, respectively.
iv) Evaluate the mean journey speed and running speed and then interpret the result.

(15 marks)

(b) Two students decided to conduct a travel time study using the car moving observer method on a section of highway. They carried out 5 runs and obtained the following data:

- Mean time to travel eastward = 2.75 min
- Mean time to trawel westbound = 2.95 min
- Average number of vehicles travelling westward when test vehicle was travelling eastward = 80
- Average number of vehicles travelling eastward when test vehicle was travelling westward = 78
- Average number of vehicles overtook the test vehicle while it was travelling westward = 2
- Average number of vehicles overtook the test vehicle while it was travelling eastward = 1
- Average number of vehicles the test vehicle passed while traveling westward = 1
- Average number of vehicles the test vehicle passed while traveling eastward = 1

Determine the travel time and volume in each direction (Eastbound and Westbound) at this section of the highway.

(10 marks)

(25 marks)

Q3. As part of a class project, a group of students collected a total of 200 headway data on Skudai-Pontian Highway. The data were then plotted as figure Q3(a).

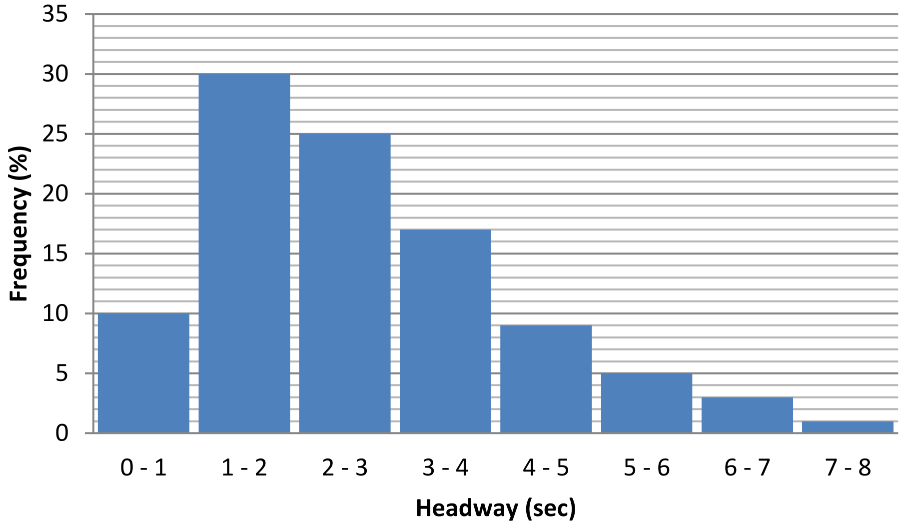


Figure Q3(a)

(a) Tabulate the data in a proper table. Then, determine and show on the histogram and cumulative frequency curve :

i) the mean headway

ii) the median

iii) the mode

iv) the standard deviation

v) the standard error

vi) the type of distribution

(15 marks)

(b) If the project required that the confidence level be 95% and the limit of acceptable error was 0.3 sec, did these students satisfy the project requirement?

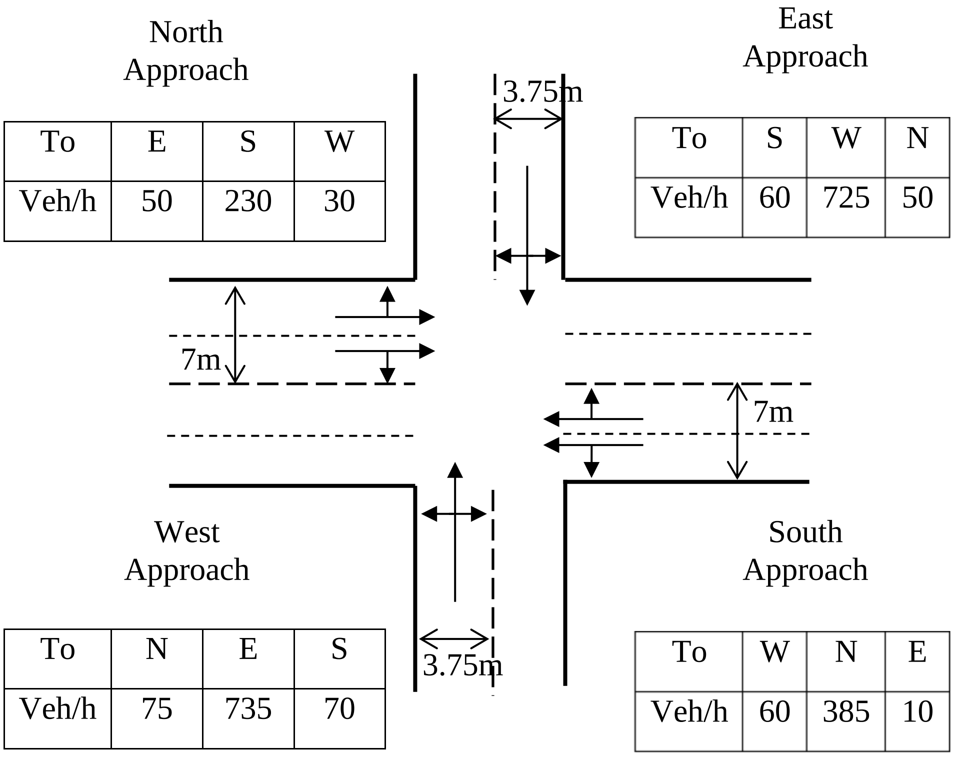
(5 marks)

(c) Based on information in (a), determine the average density in a lane if the average speed of vehicles is 50 km/h.

(5 marks)

(25 marks)

Q4. A major road with two lane running East-West direction meets a minor road having one lane running in North-South direction. The traffic flow and geometric data for this four-legged intersection is shown in Figure Q4(a). Note that the average turning radius is 28 m, average passenger car equivalent is 1 vehicle = 1.1 pcu and the road is sloping -3% towards South.



North Approach

To	E	S	W
Veh/h	50	230	30

East Approach

To	S	W	N
Veh/h	60	725	50

West Approach

To	N	E	S
Veh/h	75	735	70

South Approach

To	W	N	E
Veh/h	60	385	10

Figure Q4(a)

(a) Propose an appropriate number and the sequence of the traffic phases for the given intersection. State the reason(s) for the choice.

(b) Determine the optimum cycle time and the green period for each traffic phase. An all-red period (R) for each phase may be taken as 2 sec, an amber period (a) of 3 sec and the starting delay (*l*) is assumed 2 sec per phase. Other adjustment factors are as given in Tables 1-4 on page 8.

(c) Draw the proposed sequence of traffic phases and the timing diagram.

(25 marks)

Q5. (a) Determine the stopping sight distance required to avoid head on collision of two cars approaching from opposite directions at speed of 72 km/h on a 4% upgrade and 83 km/h on a 4% downgrade. Assume that the perception-reaction time of drivers is 2.5 sec and the coefficient between road surface and tyres is 0.4.

(5 marks)

(b) An engineer is assigned to find some information from a vertical curve of 350 m. Knowing that the gradients are +4% uphill and -5% downhill, the PVI is located at station 14+25 and the elevation is 160 m. Determine:

i) the station of the BVC and the EVC;
ii) the elevation of the BVC and the EVC; and
iii) the location and elevation of the high point on the curve.

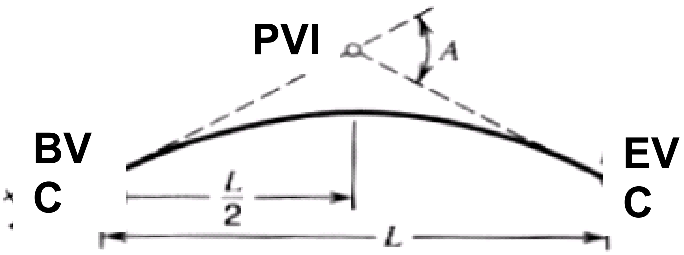


Figure 5(a)

(20 marks)
(25 marks)

EQUATIONS

The symbols indicate parameters usually used.

$$Q_{AB} = \frac{X_{AB} + (Y_1 - Y_2)_{AB}}{t_A + t_W}$$

$$t_{AB} = t_W - \frac{(Y_1 - Y_2)_{AB}}{Q_{AB}}$$

$$u = u_f - \left(\frac{u_f}{k_j}\right) \times k$$

$$q = k_j \times u - \left(\frac{k_j}{u_f}\right) \times u^2$$

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

$$\overline{V_i} = \frac{\sum (f_i V_i)}{\sum f_i}$$

$$SD = \sqrt{\left(\frac{\sum f_i V_i^2}{\sum f_i} - \left(\frac{\sum f_i V_i}{\sum f_i}\right)^2\right)}$$

$$\text{Perception Distance} = 0.28Vt$$

$$\text{Braking distance} = \frac{V^2 - u^2}{254(f \pm G)}$$

$$A = G_2 - G_1 \quad r = \frac{G_2 - G_1}{L}$$

$$Y_X = \frac{rx^2}{2} + G_1 x + Y_0$$

$$\frac{dY_X}{dx} = rx + G_1$$

$$R = \frac{V^2}{127(e + f)}$$

$$\alpha = \theta - 2\theta_P \,, \; \theta_P = 57.3\frac{L_P}{2R}$$

$$\text{Length of circular segment, } L_B = R \times \frac{2\pi\theta}{360}$$

$$\text{Length of transition curve, } L_P = \frac{V^3\left(1 - \frac{R.g.e}{V^2}\right)}{c.R}$$

$$L = \frac{AS^2}{2\left(\sqrt{h_1} + \sqrt{h_2}\right)^2}$$

$$L = 2S - \frac{2\left(\sqrt{h_1} + \sqrt{h_2}\right)^2}{A}$$

$$S_R = \frac{b}{\left(1 + \frac{1.524}{r}\right)}$$

b = 1800 for single lane
b = 3000 for two lanes

I = R + a ,   S = 525W

$$a = \frac{V}{2A} + \frac{W' + L'}{V} \quad y_i = \frac{q_i}{S_i}$$

$$Y = \sum_{i=1}^{n} y_i \qquad L = \sum_{i=1}^{n} R_i + \sum_{i=1}^{n} l_i$$

$$N = \left(\frac{z\sigma}{d}\right)^2 \quad z = \frac{(x - \mu)}{\sigma}$$

$$\textit{Optimum Cycle Time}, C_O = \frac{1.5L + 5}{1 - Y}$$

$$\textit{Effective green}, g_i = \frac{y_i}{Y}(C_O - L)$$

Actual green time $G_i = g_i + l + R$

Controller green time $K_i = g_i + l - a$

Table 1: Saturation flow for lane width equal to 5.5 m or less

W	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25
S	1845	1860	1885	1915	1965	2075	2210	2375	2560	2760

Table 2: Adjustment factors for the effects of gradient

Adjustment factor, Fg	Conditions
0.85	for upgrade 5%
0.88	for upgrade 4%
0.91	for upgrade 3%
0.94	for upgrade 2%
0.97	for upgrade 1%
1.00	for flat road
1.03	for downgrade 1%
1.06	for downgrade 2%
1.09	for downgrade 3%
1.12	for downgrade 4%
1.15	for downgrade 5%

Table 3: Adjustment factors for turning radius effects

Adjustment factor, Ft	Conditions
0.85	for turning radius, $R < 10m$
0.90	for turning radius where $10m \leq R < 15m$
0.96	for turning radius where $15m \leq R < 30m$

Table 4: Adjustment factors for the effects of turning movements

% turning traffic	Factor for right-turn, Fr	Factor for left-turn, Fl
5	0.96	1.00
10	0.93	1.00
15	0.90	0.99
20	0.87	0.98
25	0.84	0.97
30	0.82	0.95
35	0.79	0.94
40	0.77	0.93
45	0.75	0.92
50	0.73	0.91
55	0.71	0.90
60	0.69	0.89