School of
Civil Engineering

UNIVERSITI TEKNOLOGI MALAYSIA

FINAL EXAMINATION
SEMESTER II, SESSION 2018/2019

COURSE CODE	:	SKAA3842 / SAB3842
COURSE	:	TRAFFIC ENGINEERING
PROGRAMME	:	SKAW
DURATION	:	2 HOURS
DATE	:	JUNE 2019

INSTRUCTION TO CANDIDATES:

1. ANSWER ANY FOUR (4) 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 NOTE.

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 consist of (7) printed pages only.

Q1. Moving observer method was used to determine the flow and running speed of a rural road section at two different times. The length of the test section is 500 m. Table Q1 are the data (averaged) obtained during the study:

TABLE Q1

Run Number	Travel time with traffic, (sec)	Number of vehicle overtaking	Number of vehicle overtaken	Travel time against traffic, (sec)	Number of vehicle met while travelling against traffic
1	38	4	3	198	20
2	170	1	2	100	86

a) Calculate flow and speed of the traffic stream for both runs;
b) Establish the relationship between speed and density for the road section; and
c) Determine speed and spacing when flow is 800 veh/hr.

(25 marks)

Q2. a) A traffic study was conducted in Johor Bahru, Johor to determine the speed of vehicles. Discuss two methods that can be used to obtain the speed of vehicles.

(8 marks)

b) Table Q2 shows speed data collected along a road section in Johor Bahru, Johor.

TABLE Q2

Speed class (km/hr)	**Frequency**
30-35	5
35-40	9
40-45	15
45-50	25
50-55	30
55-60	50
60-65	45
65-70	35
70-75	25
75-80	11

i) Draw the histogram and cumulative frequency curve of the speed data and determine:
- mean speed
- mode
- standard deviation
- 15^{th} percentile, 50^{th} percentile and 85^{th} percentile.

ii) If the posted speed limit of the road section is 60 km/hr, what can be concluded on the traffic and road condition in the study area?

iii) The project required that the confidence level be 95% and the limit of acceptable error was 0.5 km/hr. Did the sample satisfies the project requirement?

(17 marks)
(25 marks)

Q3. a) For the geometric and traffic characteristics shown in Table Q3, determine a suitable signal phasing system and phase lengths for the intersection if the turning radius, R = 30 m and slope from east to west is -4%. The average passenger car equivalent is 1 veh = 1.3 pcu. Show the traffic phase sequences and timing diagrams if all red period may be taken as 2 sec/phase, starting delays equal to 2sec/phase and an amber period of 3 sec. Other adjustment factors are as given in Tables Q3(a) – (d).

TABLE Q3

	Width (m)	Traffic Volume (veh/hr)		
		Left	Through	Right
East	6	60	180	80
West	6	85	360	90
North	6.5	95	400	170
South	6.5	85	200	150

(20 marks)

b) Determine the reduction of conflicting points for the respective intersection based on the signal phasing designed in Q3 (a).

(5 marks)
(25 marks)

Q4. In the design of a horizontal alignment of a rural road from point X to point Y (Figure Q4), two curves are needed. Combination of two transition curves and circular curve are suggested for the first curve. While for the second curve, simple circular curve is suggested. The radius of the first circular curve is 500 m and the radius of the second circular curve is 550 m. If the rate of increase of centrifugal acceleration is 0.35 m/s^3 and superelevation is 8%:

a) Determine the length of transition curves and circular curves for the design speed of 100 km/h.

b) Determine the station for each beginning and ending point of transition curve and circular curve for that particular alignment.

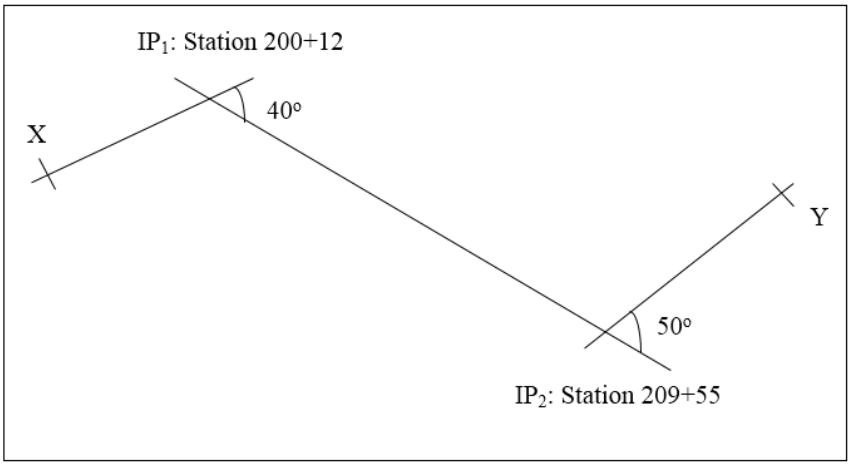

FIGURE Q4

(25 marks)

Q5. a) Describe Average Daily Traffic (ADT) and Annual Average Daily Traffic (AADT) and their applications in traffic study.

(10 marks)

b) Explain in what way the speed of vehicle, friction between tyre and road surface and gradient of the road affect the sight distance.

(10 marks)

c) Explain the following statements in the context of traffic signal control design:
   i) The reason to include the all-red-period.
   ii) The function of an amber period.

(5 marks)

(25 marks)

EQUATIONS

The symbols indicate parameters usually used.

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L.C. = 2R \sin(\theta/2)$$

$$T = R \tan(\theta/2)$$

$$E = T \tan(\theta/4)$$

$$M = E \cos(\theta/2)$$

$$P.C. = P.I. - T$$

$$P.T. = P.C. + L$$

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

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

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

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

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

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

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

I = R + a, S = 525W

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

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

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

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

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

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

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

Table Q3 (a): 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 Q3 (b): 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 Q3 (c): Adjustment factors for turning radius effects

Adjustment factor, Ft	Conditions
0.85	for turning radius, R < 10m
0.90	for turning radius where10m ≤ R < 15m
0.96	for turning radius where 15m ≤ R < 30m

Table Q3 (d): 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

Tables of the Normal Distribution

Probability Content from -oo to Z

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990