Second Semester Examination
2018/2019 Academic Session

June 2019

EAL235 – Highway and Traffic Engineering
(Kejuruteraan Lebuh Raya dan Lalu Lintas)

Duration : 2 hours
(Masa : 2 jam)

Please check that this examination paper consists of **TEN (10)** pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEPULUH (10)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

Instructions : This paper consists of **FOUR (4)** questions. Answer **ALL** questions.

*[**Arahan** : Kertas ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

1. (a). John McAdam invented a new idea, which was named as Macadamisation. Nowadays, modern road construction still reflects McAdam's influence. Explains **TWO (2)** principles introduced by McAdam to design and construct roadways.

*John McAdam telah mengilhamkan satu idea baru, yang diberi nama "Macadamisation". Pada masa kini, pembinaan jalan raya moden masih dipengaruhi prinsip yang diterapkan oleh McAdam. Terangkan **DUA (2)** prinsip yang diperkenalkan oleh McAdam untuk rekabentuk dan pembinaan jalan raya.*

[5 marks/*markah*]

(b). In Malaysia, the road constructions have begun since before independence during the British colonial era. Discuss the status of road conditions in Malaysia before independence and the factors leading to the development of road network in the country.

Di Malaysia, pembinaan jalan telah bermula sejak sebelum kemerdekaan semasa era kolonial British. Bincangkan status keadaan jalan raya di Malaysia sebelum kemerdekaan dan faktor-faktor yang membawa kepada pembangunan rangkaian jalan raya di negara ini.

[5 marks/*markah*]

(c). Based on the information provided on the contract plan (**Table 1**), prior to starting the earthwork for a highway construction, you as a site engineer are required to calculate the amount of earth necessary for cutting and filling of the subgrade. The required information is listed as follows:

*Berdasarkan maklumat yang diberikan dalam pelan kontrak (**Jadual 1**), sebelum memulakan kerja tanah untuk pembinaan lebuh raya, anda sebagai jurutera tapak, dikehendaki mengira jumlah tanah yang terlibat dalam kerja pemotongan dan pengisian untuk lapisan subgred. Maklumat yang diperlukan adalah seperti berikut:*

(i). Cut and fill volumes
Isipadu potong dan isi

(ii). Adjusted fill
Larasan isipadu isi

(iii). Exact volume
Isipadu tepat

(iv). Accumulated volume
Isipadu terkumpul

(v). Based on the provided stations and the calculated accumulated volume, **PLOT** a mass-haul diagram on a graph paper.
*Berdasarkan stesen yang diberi dan isipadu terkumpul yang dikira, **PLOT** gambar rajah angkut jisim di atas kertas graf.*

Shrinkage factor: 1.5
Faktor Pengecutan: 1.5

Distance between station = 100 m
Jarak antara stesen: 100 m

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Table 1: Cut and Fill data between stations 0 to 3
Jadual 1: Data potong dan isi di antara stesen 0 ke 3

Station/ *Stesen*	Area/ *Luas* (m^2)		Volume/ *Isipadu* (m^3)		Adjusted Fill/ *Isi Larasan* (m^3)	Exact volume/ *Isipadu Tepat* (m^3)	Accumulated Volume/ *Isipadu Terkumpul* (m^3) Cut/ *Potong*
	Cut/ *Potong*	Fill/ *Isi*	Cut/ *Potong*	Fill/ *Isi*			
0	70	20					
1	120	80					
2	137	110					
3	60	120					

[15 marks/*markah*]

2. (a). Traffic survey was conducted at the mid-block of a road section in a rural area. Based on the data collected in **Table 2**:

*Kajian trafik telah dijalankan di pertengahan blok segmen jalan dalam kawasan luar bandar. Berdasarkan data yang dicerap dalam **Jadual 2**:*

(i). Calculate the 5-min flow rate, 15-min volume and 15-min flow rate.

Kira kadar aliran 5-min, isipadu 15-min dan kadar aliran 15-min.

(ii). Determine the peak hour volume and peak flow rate. Explain the differences between peak hour volume and peak hour flow rate.

Tentukan isipadu waktu puncak dan kadar aliran waktu puncak. Terangkan perbezaan antara isipadu waktu puncak dan kadar aliran waktu puncak.

[15 marks/*markah*]

Table 2: Traffic volume
Jadual 2: Isipadu trafik

Time period *Jangka masa*	Volume (pcu) *Isipadu (ukp)*
6:45 - 6:50	155
6:50 - 6:55	150
6:55 - 6:00	142
7:00 - 7:05	145
7:05 - 7:10	132
7:10 - 7:15	122
7:15 - 7:20	156
7:20 - 7:25	147
7:25 - 7:30	170
7:30 - 7:35	168
7.35 - 7:40	154
7:40 - 7:45	156
7:45 - 7:50	164
7:50 - 7:55	142
7:55 - 8:00	124

(b). Based on the graph shown in **Figure 1**, percent time-spent-following (PTSF) and average travel speed (ATS) are the two performance measures used in Malaysia Highway Capacity Manual (2011) to determine the capacity and level-of-service (LOS) of two-lane two-way highways. With the aid of sketches, explain the meaning of PTSF and ATS and the relationship between PTSF and ATS.

*Berdasarkan kepada graf yang ditunjukkan dalam **Rajah 1**, peratusan masa membazir mengekor (PTSF) dan purata kelajuan perjalanan (ATS) merupakan dua ukuran prestasi yang digunakan dalam Malaysia Highway Capacity Manual (2011) untuk menentukan kapasiti dan aras perkhidmatan (LOS) lebuhraya dua lorong dua hala. Dengan berbantukan lakaran, terangkan maksud PTSF dan ATS dan hubungan antara PTSF dan ATS.*

[10 marks/*markah*]

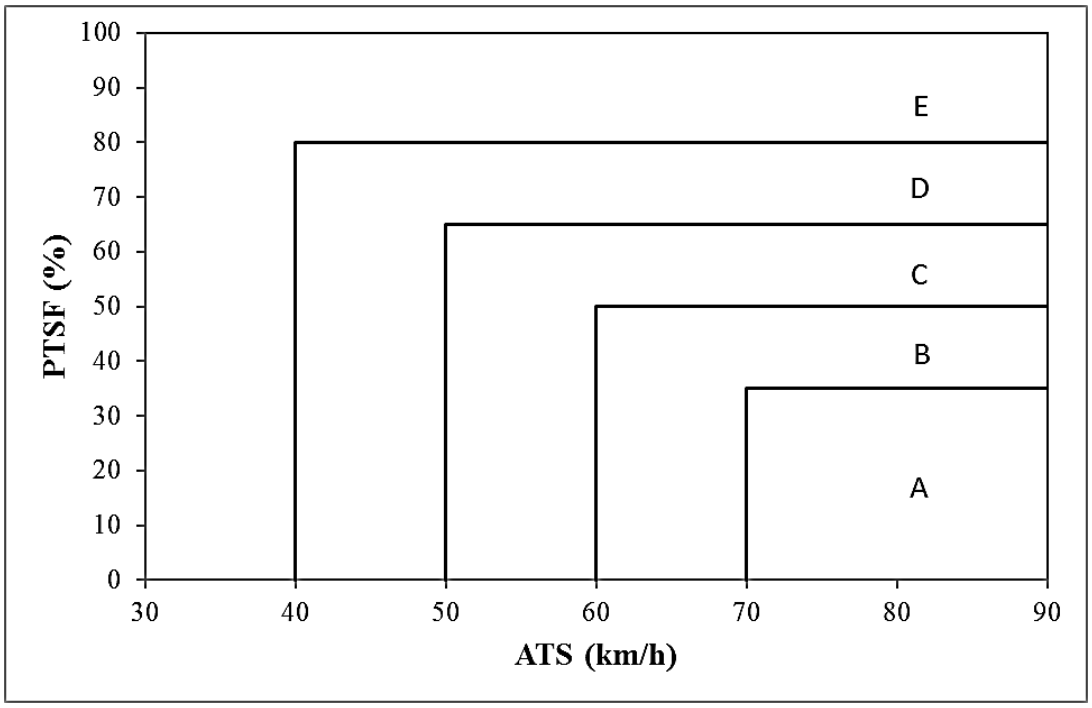

Figure 1: LOS criteria for two-lane two-way highway
Rajah 1: Kriteria LOS untuk lebuhraya dua lorong dua hala

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3. (a). Spot speed study is conducted to investigate the speed distribution of vehicles in a traffic stream at a particular road location. Speed data are frequently presented in speed classes to plot the cumulative frequency curve. By using the provided graph paper, **plot to scale** the cumulative frequency curve based on the speed data given in **Table 3**. From the graph, determine the suitable speed limit and explain how the value is obtained. **Attach the plotted cumulative curve together with the answer script.**

Kajian kelajuan setempat dijalankan untuk mengkaji agihan kelajuan kenderaan dalam aliran lalulintas di lokasi jalan tertentu. Data kelajuan sering dibentangkan dalam kelas kelajuan untuk melukis lengkung kekerapan kumulatif. Dengan menggunakan kertas graf yang disediakan, ***plot mengikut skala*** *lengkung kekerapan kumulatif berdasarkan data kelajuan yang diberikan dalam* ***Jadual 3****. Daripada graf, tentukan had laju yang sesuai dan terangkan bagaimana nilai itu diperoleh.* ***Lampirkan lengkung kumulatif yang telah diplot bersama dengan skrip jawapan.***

[13 marks/*markah*]

Table 3: Speed data
Jadual 3: Data kelajuan

Speed class *Kelas kelajuan* (km/hr)	Frequency *Kekerapan*
40-44	10
45-49	22
50-54	30
55-59	34
60-64	46
65-69	40
70-74	35
75-79	21
80-84	18
85-89	16
90-94	9

(b). With the aid of sketches, discuss the following relationships:
Dengan berbantukan lakaran, bincangkan hubungan yang berikut:

(i). speed and flow,
kelajuan dan aliran,

(ii). speed and density,
kelajuan dan ketumpatan,

(iii). flow and density.
aliran dan ketumpatan.

Subsequently, explain the meaning of free-flow speed and jam density in the speed-flow, speed-density and flow-density relationships.

Seterusnya, terangkan maksud kelajuan aliran-bebas dan ketumpatan sesak dalam hubungan kelajuan-aliran, kelajuan-ketumpatan dan aliran-ketumpatan.

[12 marks/*markah*]

4. (a). Calculate saturation flow in pcu/hr based on the data given in **Table 4**. Subsequently, **SKETCH** the saturation flow diagram. Calculate the initial and final lost time.

*Kira aliran tepu dalam ukp/jam berdasarkan kepada maklumat yang diberi dalam **Jadual 4**. Seterusnya, **LAKARKAN** gambarajah aliran tepu. Kira masa hilang awal dan masa hilang akhir.*

[15 marks/*markah*]

Table 4: Saturation flow data
Jadual 4: Data aliran tepu

Cycle no *No. kitar*	Number of vehicles (pcu) in every 6 seconds interval *Bilangan kenderaan (ukp) dalam setiap selang 6 saat*								Others *Lain-lain*	Saturated? *Tepu?*	Green time (s) *Masa hijau (s)*
	6	12	18	24	30	36	42	48			
1	2	3	4	4	4	5	3	2	-	Yes	44.30
2	1	4	3						-	No	44.72
3	2	4	3	6	5	4	3	1	-	Yes	43.98
4	2	5	5	2	2	1	2	1	-	Yes	43.81
5	4	2	6	4	5	3	2	1	-	Yes	44.89
6	2	3	2	3	2	3	3	1	-	Yes	45.11
7	3	5	3	3	5	5	4	0	-	Yes	45.72
8	3	4	3	4	3	5	3	0	-	Yes	44.42
9	3	3	5	4	2	5	3	1	-	Yes	43.88
10	3	3	4	2	6	4	4	1	-	Yes	44.48

(b). A signalised intersection with **THREE PHASES** is proposed as shown in **Figure 2**. The actual green time for each movement is as shown in **Table 5**. Left-turn movements are continuous. Sketch the followings:

*Satu persimpangan lampu isyarat dengan **TIGA FASA** dicadangkan seperti yang ditunjukkan dalam **Rajah 2**. Masa hijau sebenar bagi setiap pergerakan ditunjukkan dalam **Jadual 5**. Pergerakan belok kiri adalah berterusan. Lakarkan yang berikut:*

(i). the three-phase signal phasing,
fasa isyarat tiga-fasa,

(ii). phase timing distribution diagram for each movement
gambarajah agihan masa fasa untuk setiap pergerakan

(iii). ring diagram.

Gambarajah cincin.

Based on the sketches in (i) and (ii), calculate the cycle time.

Berdasarkan lakaran dalam (i) dan (ii), kirakan masa kitar.

[10 marks/*markah*]

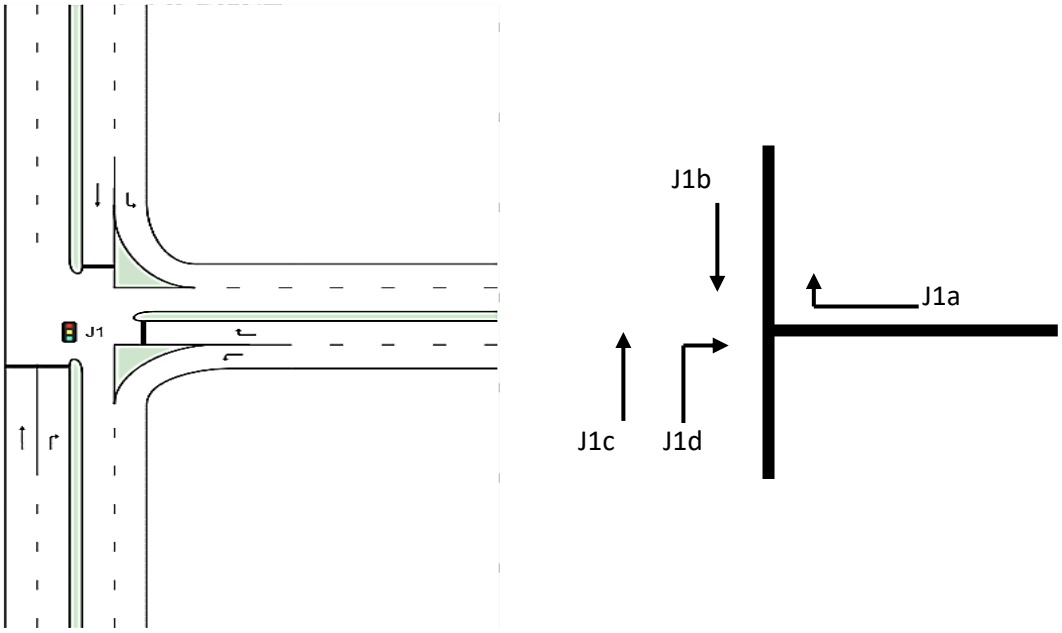

Figure 2: Proposed signalized intersection with direction of movement
Rajah 2: Cadangan persimpangan lampu isyarat dengan arah pergerakan

Table 5: Optimum signal timing
Jadual 5: Masa isyarat optimum

Movement *Pergerakan*	Start green time (s) *Masa mula hijau (s)*	Green time (s) *Masa hijau (s)*
J1a	37	18
J1b	60	20
J1c	60	57
J1d	0	32

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