UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	TRAFFIC ENGINEERING AND SAFETY
COURSE CODE	:	BFC3082
PROGRAMME	:	3 BFF
EXAMINATION DATE	:	APRIL / MAY 2011
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	ANSWER THREE (3) QUESTIONS ONLY.

THIS PAPER CONSISTS OF TWENTY (20) PAGES

Q1 (a) Draw the curves to describe the relationships between speed and density, speed and flow, and flow and density.

(3 marks)

(b) Four vehicles are traveling at constant speeds between sections X and Y (280 meters apart) with their positions and speeds observed at an instant in time. An observer at point X observed four vehicles passing point X during a period of 15 seconds. The speeds of the vehicles were measured as 88, 80, 90, and 72 km/hr respectively. Determine:

(i) Flow of the vehicles.

(1 mark)

(ii) Density of the vehicles.

(1 mark)

(iii) Time mean speed of the vehicles.

(1 mark)

(iv) Space mean speed of the vehicles.

(3 marks)

(c) A new 3.2-km segment of multilane highway with right-of-way width of 27.4 metres. Given;

- Directional Design Hourly Volume, DDHV = 3,300 veh/hr
- Rolling Terrain
- 5% Trucks
- 80.0 km/hr speed limit
- 6 access points/km
- Peak Hour Factor = 0.90
- Assume Commuter Traffic

Determine the cross section required to meet the design criterion of LOS D.

(16 marks)

Q2 (a) A car is travelling at 90 km/h on a crest vertical curve connecting grades of +2% and -1%. Length of the curve is 250 m. Further ahead of the car, an object from a truck has fallen onto the travel lane. The height of the object is 80 cm. Eye height is taken as 1.06 m. Ignore the effects of grades on stopping sight distance. Drivers' perception-reaction time is taken as 2.5 seconds.

Calculate the minimum length requires for the car to stop safely and avoid colliding with the object.

(5 marks)

(b) Write briefly about transition curve.

(2 marks)

(c) Sketch an appropriate diagram showing the relationship between tangent, transition and circular curves.

(3 marks)

(d) The following measurements will be used in the design of a sag vertical curve road construction:

Gradient G_1	= -2.0%
Gradient G_2	= +3.0%
Design speed	= 80 km/h
Elevation at BVC	= 12.50 m
Elevation at EVC	= 13.20 m

(i) Design the stations for the sag vertical curve at 20 m intervals by using **Table 10**.

(ii) Determine the location of the minimum point on the curve.

(iii) Sketch the vertical curve.

(15 marks)

Q3 (a) Explain briefly the **TWO (2)** approaches that most commonly applied in ***Safety management and strategies to prevent and reduce the rate of accident and casualty*** in both urban and rural areas.

(5 marks)

(b) Following are **FOUR (4)** basic strategies to reduce the number of accident:

- Single site/Blackspot treatment
- Mass action schemes
- Route action plans, and
- Area-wide schemes

Explain and give **TWO (2)** examples on each strategy

(20 marks)

Q4 (a) Discuss **FIVE (5)** approaches how transit and High Occupancy Vehicle (HOV) can reduce traffic congestion.

(10 marks)

(b) If a suggested parking area of a hypermarket is 60 meter x 14 meter;

(i) Suggest the best layout to maximize the number of vehicles that can park at the area.

(ii) Explain **SIX (6)** advantages of your suggestion.

(9 marks)

(c) An office parking garage has the hours of operation from 6:00 to 20:00 and the number of parking bays in the garage is 500. 80% of the users are commuters with average parking duration of 8 hours while 10% are visitors parking for an average of 2 hours. The remaining are shoppers parking for an average of 3 hours. However observations made at the garage indicate that 15% of visitors from 10:00 to 12:00 and from 13:00 to 15:00, could not find parking.

Calculate how many additional bays should be added to meet the demand.

(6 marks)

Q5 (a) Give **THREE (3)** traffic signal warrants to be considered before installing any signal control.

(3 marks)

(b) **Table 12** shows traffic flow data and saturation flow for each approach at a traffic signal intersection. Amber time, a = 3s , all red interval, R= 2s and driver reaction time, *l*= 2s.

(i) Complete **Table 12.**

(7 marks)

(ii) Determine optimum cycle time.

(5 marks)

(iii) Determine effective green time, actual green time and controller setting time.

(6 marks)

(iv) Sketch timing schedule.

(4 marks)

S1 (a) Lukiskan graf lengkungan yang menerangkan perkaitan di antara laju dan ketumpatan, laju dan aliran, serta aliran dan ketumpatan.

(3 markah)

(b) Empat kenderaan sedang dalam perjalanan dari seksyen X ke seksyen Y (pada jarak 280 meter) pada laju seragam diperhatikan dengan kedudukan dan kelajuan pada masa tertentu. Seorang pemerhati yang berada pada titik X memerhati empat kenderaan tersebut melalui titik X dalam masa 15 saat. Kelajuan kenderaan-kenderaan tersebut masing-masing pada 88, 80, 90 dan 72 km/jam. Berdasarkan data tersebut, dapatkan:

(i) Aliran.

(1 markah)

(ii) Ketumpatan.

(1 markah)

(iii) Laju Purata Masa.

(1 markah)

(iv) Laju Purata Ruang.

(3 markah)

(c) Jalan raya berbilang lorong yang baru sepanjang 3.2 kilometer dibina dengan lebar keseluruhan lebuhraya sebanyak 27.4 meter.

Diberi;

- Isipadu Jam Rekabentuk Sehala, DDHV = 3,300 kenderaan/jam
- Kawasan beralun
- 5% lori
- Had laju ialah 80.0 km/jam
- 6 titik keluar masuk/km
- Faktor Jam Puncak = 0.90
- Andaian trafik komuter

Dapatkan keratan rentas jalan yang diperlukan untuk memenuhi kriteria rekabentuk jalan tersebut bagi menghasilkan tahap perkhidmatan D.

(16 markah)

S2 (a) Sebuah kereta sedang dipandu pada kelajuan 90 km/j pada lengkung pugak jenis puncak yang menghubungkan kecerunan +2% dan -1%. Panjang lengkung adalah 250 m. Terdapat suatu objek terjatuh di lorong laluan daripada trak di hadapan kereta tersebut. Ketinggian objek tersebut ialah 80 cm. Ketinggian mata ialah 1.06 m. Abaikan kesan kecerunana pada jarak penglihatan berhenti. Masa persepsi-reaksi pemandu ialah 2.5 saat.

Kirakan jarak minima yang diperlukan oleh kereta untuk berhenti dengan selamat tanpa melanggar objek tersebut.

(5 markah)

(b) Tuliskan secara ringkas mengenai lengkung peralihan.

(2 markah)

(c) Lakarkan rajah yang sesuai untuk menunjukkan hubungan antara garis tangen, lengkung peralihan dan lengkung bulat.

(3 markah)

(d) Pengukuran berikut akan digunakan untuk reka bentuk lengkung pugak jenis lendut untuk pembinaan jalan:

Kecerunan G_1	= -2.0%
Kecerunan G_2	= +3.0%
Laju reka bentuk	= 80 km/h
Aras ketinggian di BVC	= 12.50 m
Aras ketinggian di EVC	= 13.20 m

(i) Reka bentuk stesyen untuk lengkung lendut pugak pada jarak 20 m dengan menggunakan **Jadual 10**.

(ii) Dapatkan lokasi titik minimum pada lengkung.

(iii) Lakarkan lengkung pugak.

(15 markah)

S3 (a) Terangkan secara ringkas **DUA (2)** pendekatan yang sering digunapakai didalam pengurusan keselamatan dan strategi untuk menghalang serta mengurangkan kadar kemalangan dan korban kawasan bandar dan luar bandar.

(5 markah)

(b) Terdapat **EMPAT (4)** strategi asas (disenaraikan dibawah) yang boleh digunakan bagi mengurangkan jumlah kemalangan.

- *Single site/Blackspot treatment*
- *Mass action schemes*
- *Route action plans, and*
- *Area-wide schemes*

Terang dan berikan **DUA (2)** contoh untuk setiap strategi.

(20 markah)

S4 (a) Bincangkan **LIMA (5)** pendekatan bagaimana transit dan *High Occupancy Vehicle (HOV)* atau Kenderaan dengan Kadar Penumpang Tinggi dapat mengurangkan kesesakan trafik.

(10 markah)

(b) Sekiranya satu lokasi cadangan untuk tempat meletak kenderaan sebuah pasaraya ialah 60 meter x 14 meter;

(i) Cadangkan susur atur terbaik untuk memaksimakan jumlah kenderaan yang dapat meletak kenderaan di kawasan tersebut.

(ii) Terangkan **ENAM (6)** kebaikan cadangan anda.

(9 markah)

(c) Sebuah garaj pejabat beroperasi dari pukul 6:00 pagi ke 8:00 malam dan jumlah ruang parker ialah sebanyak 500. 80% daripada pengguna adalah komuter dengan purata jangkamasa meletak kenderaan selama 8 jam, manakala 10% adalah pelawat dengan purata jangkamasa meletak kenderaan selama 2 jam. Selebihnya adalah pekedai dengan purata 3 jam meletak kenderaan. Walau bagaimanapun, berdasarkan pemerhatian di garaj tersebut, terdapat 15% pelawat dari pukul 10:00 pagi hingga 12:00 tengahari dan 1:00 tengahari hingga 3:00 petang tidak dapat meletak kenderaan mereka.

Hitung berapa ruang parkir tambahan yang diperlukan bagi memenuhi permintaan meletak kenderaan di garaj tersebut.

(6 markah)

S5 (a) Berikan **TIGA (3)** waran yang perlu dipertimbangkan sebagai syarat pemilihan pemasangan lampu isyarat.

(3 markah)

(b) **Jadual 12** menunjukkan data aliran trafik dan aliran tepu bagi setiap arah masukan di persimpangan lampu isyarat. Masa kuning, a=3s , semua merah, R= 2s dan masa tindakbalas pemandu, l= 2s.

(i) Lengkapkan **Jadual 12**.

(7 markah)

(ii) Kirakan masa kitar optimum.

(5 markah)

(iii) Kirakan masa hijau berkesan, masa hijau sebenar dan masa kawalan set.

(6 markah)

(iv) Lakarkan gambarajah masa.

(4 markah)

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Table 1: LOS Criteria for multilane highways

		LOS				
Free-Flow Speed	Criteria	A	B	C	D	E
100 km/h	Maximum density (pc/km/ln)	7	11	16	22	25
	Average speed (km/h)	100.0	100.0	98.4	91.5	88.0
	Maximum volume to capacity ratio (v/c)	0.32	0.50	0.72	0.92	1.00
	Maximum service flow rate (pc/h/ln)	700	1100	1575	2015	2200
90 km/h	Maximum density (pc/km/ln)	7	11	16	22	26
	Average speed (km/h)	90.0	90.0	89.8	84.7	80.8
	Maximum v/c	0.30	0.47	0.68	0.89	1.00
	Maximum service flow rate (pc/h/ln)	630	990	1435	1860	2100
80 km/h	Maximum density (pc/km/ln)	7	11	16	22	27
	Average speed (km/h)	80.0	80.0	80.0	77.6	74.1
	Maximum v/c	0.28	0.44	0.64	0.85	1.00
	Maximum service flow rate (pc/h/ln)	560	880	1280	1705	2000
70 km/h	Maximum density (pc/km/ln)	7	11	16	22	28
	Average speed (km/h)	70.0	70.0	70.0	69.6	67.9
	Maximum v/c	0.26	0.41	0.59	0.81	1.00
	Maximum service flow rate (pc/h/ln)	490	770	1120	1530	1900

Note:
The exact mathematical relationship between density and volume to capacity ratio (v/c) has not always been maintained at LOS boundaries because of the use of rounded values. Density is the primary determinant of LOS. LOS F is characterized by highly unstable and variable traffic flow. Prediction of accurate flow rate, density, and speed at LOS F is difficult.

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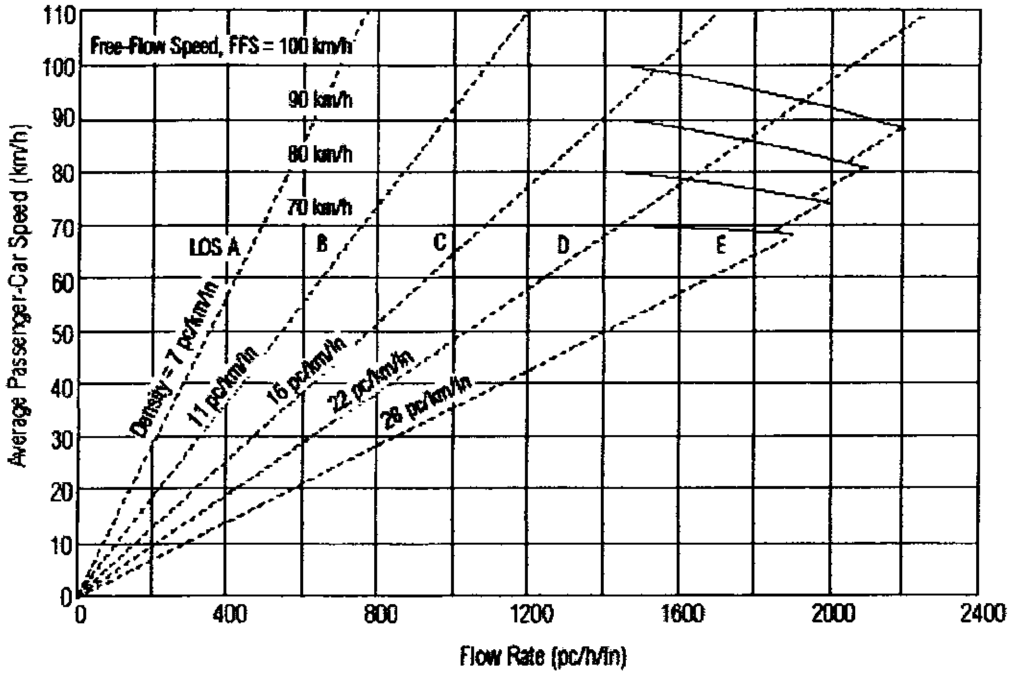

Note:
Maximum densities for LOS E occur at a v/c ratio of 1.0. They are 25, 26, 27, and 28 pc/km/ln at FFS of 100, 90, 80, and 70 km/h, respectively. Capacity varies by FFS. Capacity is 2,200, 2,100, 2,000, and 1,900 pc/h/ln at FFS of 100, 90, 80, and 70 km/h, respectively.

Figure Q1 (c): Speed-Flow Curves with LOS Criteria

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Table 2: Adjustment for Lane Width

Lane Width (m)	Reduction in FFS (km/h)
3.6	0.0
3.5	1.0
3.4	2.1
3.3	3.1
3.2	5.6
3.1	8.1
3.0	10.6

Table 3: Adjustment for Lateral Clearance

Four-Lane Highways		Six-Lane Highways	
Total Lateral Clearance[a] (m)	Reduction in FFS (km/h)	Total Lateral Clearance[a] (m)	Reduction in FFS (km/h)
3.6	0.0	3.6	0.0
3.0	0.6	3.0	0.6
2.4	1.5	2.4	1.5
1.8	2.1	1.8	2.1
1.2	3.0	1.2	2.7
0.6	5.8	0.6	4.5
0.0	8.7	0.0	6.3

Note:
a. Total lateral clearance is the sum of the lateral clearances of the median (if greater than 1.8 m, use 1.8 m) and shoulder (if greater than 1.8 m, use 1.8 m). Therefore, for purposes of analysis, total lateral clearance cannot exceed 3.6 m.

Table 4: Adjustment for Median Type

Median Type	Reduction in FFS (km/h)
Undivided highways	2.6
Divided highways (including TWLTLs)	0.0

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Table 5: Adjustment for Access Point Density

Access Points/Kilometer	Reduction in FFS (km/h)
0	0.0
6	4.0
12	8.0
18	12.0
≥ 24	16.0

Table 6: Passenger Car Equivalents on Extended General Highway Segments

Factor	Type of Terrain		
	Level	Rolling	Mountainous
E_T (trucks and buses)	1.5	2.5	4.5
E_R (RVs)	1.2	2.0	4.0

Table 7: Passenger Car Equivalents for Trucks and Buses on Downgrades

Downgrade (%)	Length (km)	E_T			
		Percentage of Trucks			
		5	10	15	20
< 4	All	1.5	1.5	1.5	1.5
4–5	≤ 6.4	1.5	1.5	1.5	1.5
4–5	> 6.4	2.0	2.0	2.0	1.5
> 5–6	≤ 6.4	1.5	1.5	1.5	1.5
> 5–6	> 6.4	5.5	4.0	4.0	3.0
> 6	≤ 6.4	1.5	1.5	1.5	1.5
> 6	> 6.4	7.5	6.0	5.5	4.5

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Table 8: Passenger Car Equivalents for Trucks and Buses on Uniform Upgrades

Upgrade (%)	Length (km)	E_T Percentage of Trucks and Buses								
		2	4	5	6	8	10	15	20	25
<2	All	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
≥ 2–3	0.0–0.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 0.4–0.8	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 0.8–1.2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 1.2–1.6	2.0	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5
	> 1.6–2.4	2.5	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.0
	> 2.4	3.0	3.0	2.5	2.5	2.0	2.0	2.0	2.0	2.0
> 3–4	0.0–0.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 0.4–0.8	2.0	2.0	2.0	2.0	2.0	2.0	1.5	1.5	1.5
	> 0.8–1.2	2.5	2.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	> 1.2–1.6	3.0	3.0	2.5	2.5	2.5	2.5	2.0	2.0	2.0
	> 1.6–2.4	3.5	3.5	3.0	3.0	3.0	3.0	2.5	2.5	2.5
	> 2.4	4.0	3.5	3.0	3.0	3.0	3.0	2.5	2.5	2.5
> 4–5	0.0–0.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 0.4–0.8	3.0	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.0
	> 0.8–1.2	3.5	3.0	3.0	3.0	2.5	2.5	2.5	2.5	2.5
	> 1.2–1.6	4.0	3.5	3.5	3.5	3.0	3.0	3.0	3.0	3.0
	> 1.6	5.0	4.0	4.0	4.0	3.5	3.5	3.0	3.0	3.0
> 5–6	0.0–0.4	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 0.4–0.5	4.0	3.0	2.5	2.5	2.0	2.0	2.0	2.0	2.0
	> 0.5–0.8	4.5	4.0	3.5	3.0	2.5	2.5	2.5	2.5	2.5
	> 0.8–1.2	5.0	4.5	4.0	3.5	3.0	3.0	3.0	3.0	3.0
	> 1.2–1.6	5.5	5.0	4.5	4.0	3.0	3.0	3.0	3.0	3.0
	> 1.6	6.0	5.0	5.0	4.5	3.5	3.5	3.5	3.5	3.5
> 6	0.0–0.4	4.0	3.0	2.5	2.5	2.5	2.5	2.0	2.0	2.0
	> 0.4–0.5	4.5	4.0	3.5	3.5	3.5	3.0	2.5	2.5	2.5
	> 0.5–0.8	5.0	4.5	4.0	4.0	3.5	3.0	2.5	2.5	2.5
	> 0.8–1.2	5.5	5.0	4.5	4.5	4.0	3.5	3.0	3.0	3.0
	> 1.2–1.6	6.0	5.5	5.0	5.0	4.5	4.0	3.5	3.5	3.5
	>1.6	7.0	6.0	5.5	5.5	5.0	4.5	4.0	4.0	4.0

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Table 9: Longitudinal coefficient of friction proposed for certain design speeds

Design speed (km/h)	Coefficient of friction, f
50	0.35
60	0.33
70	0.31
80	0.30
90	0.30
100	0.29
110	0.28
120	0.28

Table 10: Worksheet for the design of sag vertical curve

x	LP	x/L	$(x/L)^2$	$y_n = 4e(x/L)^2$	$L_x = LP + y_n$	Remarks

Table 11: Suggested minimum *k* values for vertical curves (JKR)

Design speed km/h	Minimum *k* value	
	Sag Curve	Crest curve
120	60	120
100	40	60
80	28	30
60	15	15
50	12	10
40	10	10
30	8	5
20	8	5

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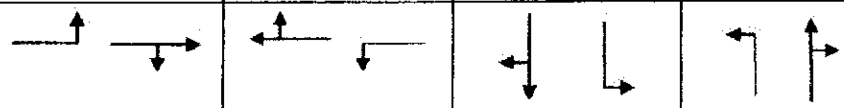
Table 12 : Traffic Flow (pcu/hour) and Saturated Flow (pcu/hour) values for each phase and movement.

Phase	Phase 1		Phase 2		Phase 3		Phase 4	
Movement	A	B	A	B	A	B	A	B
								
Traffic Flow, q (pcu/hour)	255	986	457	256	128	146	247	112
Saturated Flow (pcu/hour)	1785	3250	3250	1785	1785	3250	1785	3250
q/S								
Y								

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Formulae:

$$FFS = BFFS - f_{LW} - f_{LC} - f_M - f_A$$

$$v_p = \frac{V}{PHF * N * f_{HV} * f_p}$$

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$$

$$D = \frac{v_p}{S}$$

$$q = N\left(\frac{3600}{t_{measured}}\right)$$

$$k = \frac{N}{L}$$

$$\overline{v_t} = \frac{1}{N}\sum_{n=1}^{N} v_n$$

$$\overline{v_s} = \frac{N}{\sum_{n=1}^{N} \frac{1}{v_i}}$$

$$t_i = L/v_i$$

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$$SSD = 0.278tv + \frac{v^2}{254f}$$

When S ≤ L ; $$L_{min} = \frac{AS^2}{\left(\sqrt{2h_1} + \sqrt{2h_2}\right)^2}$$

$L = kA$

$A = G_1 - G_2$

$e = \frac{AL}{800}$

$y_n = 4e\left(\frac{x}{L}\right)^2$

$LP_n = (G_1 d) + LP_{n-1}$; where d = interval

$L_{x_n} = LP_n + y_n$

$x_{min} = \frac{G_1 L}{A}$

$y_{min} = \textit{elevation at BVC} - Y_{min}$

$Y_{min} = \frac{G_1 x_{min}}{100} - \frac{A}{200L}(x_{min})^2$

$I = R + a$

$L = \Sigma (I - a) + \Sigma l$

$Co = \frac{1.5L + 5}{1 - Y}$

$g_n = \frac{y_n}{Y}(Co - L)$

$G_n = g_n + l + R$

$K_n = G_n - a - R$