UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	TRAFFIC ENGINEERING & SAFETY
COURSE CODE	:	BFC 3082 / BFC 32302
PROGRAMME	:	3 BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	1. ANSWER **FOUR (4)** QUESTIONS ONLY. 2. ATTACH **APPENDIX I, II AND III** WITH YOUR ANSWER BOOKLET.

THIS QUESTION PAPER CONSISTS OF TWENTY SIX (26) PAGES

Q1 (a) Define gap and headway.

(4 marks)

(b) Illustrate the Speed-Flow-Density curves in traffic flow theory.

(6 marks)

(c) **Table 1** shows spot speed data collected from a spot speed study which was conducted along an accident blackspot. The data will be used to determine whether speeding was a contributing factor to the accidents, which involved high numbers of fatalities and serious injuries. The speed limit for the section of highway is 90 km/h.

(i) Complete **Table 1**.

(ii) Plot a frequency and cumulative frequency distribution curve for this data.

(iii) Based on your answer in **Q1(c)(ii),** determine the following:

(1) Pace

(2) Mean speed

(3) Median speed

(4) 85^{th} Percentile speed

(5) Percentage of vehicles in pace

(6) Percentage of vehicles travelling over the speed limit.

(iv) Justify your answer whether the speeding had contributed to the accidents at this blackspot location.

(15 marks)

Q2 (a) The deflection angle of a horizontal curve is 55°25', with D is 4°, given point of curve, PC is at station 72 + 67.88 and PV is the station at the other end of the curve.

(i) Calculate the length of curve.
(ii) Calculate tangent length.
(iii) Analyze and determine the station of PV.

(9 marks)

(b) Starting 2008 to the end of year 2011, about fourteen (14) of roads projects were constructed and widened in Johore especially in areas of Iskandar Malaysia. The vertical curve on that road is a sag vertical curve as shown in **Figure Q2** where the departure grade (G1) is -1.75% and the approach grade (G2) is +2.25%. Length of the curve is 1200 m and the elevation of vertical intersection point is 591 m.

(i) Analyze and design the vertical curve for each 100 m interval.

(ii) Analyze and determine the elevations of the minimum point.

(16 marks)

Q3 (a) Briefly explain the following road safety terminology:

(i) Accident reduction.
(ii) Accident prevention.

(5 marks)

(b) The pedestrian and motorcyclist are road users which can be categorized as the Vulnerable Road User. List **THREE (3)** activities or actions that can be carried out under safety program for both road users.

(6 marks)

(c) **Figure Q3(c)** shows Blackspot area of Jalan Bunga Raya. Based on the collision diagram and roadside environment:

(i) Identify the problems.
(ii) Propose countermeasures needed for each problem in **Q3(c)(i).**

(6 marks)

(d) In Malaysia, road accidents that were recorded in the year 1996 are 189,109 cases while in the year 2005 are 328,268 cases. Therefore, there is 74 percent of increase in road accidents within those years and majority was the head-on crashes.

As a Traffic Engineer, suggest the best solution to overcome such type of collision.

(2 marks)

(e) Road Safety Audit Stage 5 is carried out at new Merang-Kuala Besut Road and the pictures from the audit are as shown in **Figure Q3(e).**

(i) Highlight the road safety deficiencies on the figure.
(ii) Give comment as a road safety auditor based on highlighted deficiencies.

(6 marks)

Q4 (a) **Table 2** shows a large number of private vehicle usages in Kuala Lumpur. Based on the table, discuss on mode sharing between private vehicle and public transport.

Table 2: Share by mode of transport in Kuala Lumpur (2003)

Mode	Percentage (%)
Motorcycle	13
Car	71
Bus	6
Rail	10

(6 marks)

(b) Propose how the transport mode share can be balanced by the following:
(i) Parking.
(ii) Bus lane.

(6 marks)

(c) Integrated Transport Information System (ITIS) was launched in Klang Valley to ease traffic flow. ITIS is supported by two core systems, which are Advanced Traffic Management System (ATMS) and Advanced Traveler Information System (ATIS).

(i) Explain the function of ATMS and ATIS
(ii) Discuss **FOUR (4)** benefits of ITIS.

(9 marks)

(d) Based on the schematic illustration of an urban road network shown in **Figure Q4**, list down the type of roads labeled A, B, C and D.

(4 marks)

Q5 (a) Outline **FOUR (4)** principles of safe intersection design.

(4 marks)

(b) Given in **Figure Q5** is traffic flow data and saturation flow for each approach at traffic signal intersection consists an amber time, a = 3s , all red interval, R = 2s and driver reaction time, l = 4s. Analyze and design a fixed-time traffic signal for intersection given as shows in **Figure Q5.**

(21 marks)

S1 (a) Berikan definisi sela dan jarak kepala.

(4 markah)

(b) Ilustrasikan lengkungan Laju-Aliran-Ketumpatan dalam teori aliran trafik.

(6 markah)

(c) **Jadual 1** menunjukkan data laju setempat yang diambil daripada kajian laju setempat yang dijalankan di sepanjang kawasan titik hitam kemalangan. Data tersebut akan digunakan untuk menentukan sama ada memecut melebihi had laju merupakan salah satu faktor penyumbang kemalangan jalan raya yang mengakibatkan bilangan kematian dan mangsa yang cedera parah adalah tinggi. Had laju untuk seksyen jalan raya ini ialah 90km/j.

(i) Penuhkan **Jadual 1**.

(ii) Plotkan lengkung frekuensi dan agihan frekuensi kumulatif bagi data tersebut.

(iii) Berdasarkan jawapan anda di **S1(c)(ii),** tentukan berikut:

(1) Jangkah.

(2) Laju Min.

(3) Laju Median.

(4) Laju 85 peratus.

(5) Peratus kenderaan dalam jangkah.

(6) Peratus kenderaan yang memandu melebihi had laju.

(iv) Justifikasikan jawapan anda sama ada memecut merupakan faktor penyumbang kemalangan jalan raya untuk lokasi titik hitam ini.

(15 markah)

S2 (a) Sudut pesongan dalam lengkungan mendatar ialah 55°25' dan dengan nilai D ialah 4°, titik stesen permulaan lengkungan, PC ialah 72 + 67.88 dan PV adalah stesen di mana lengkungan mendatar berakhir.

(i) Kirakan panjang lengkungan.
(ii) Kirakan panjang tangent.
(iii) Analisis dan tentukan stesen PV.

(9 markah)

(b) Bermula tahun 2008 sehingga hujung tahun 2011, kira-kira empat belas (14) rangkaian projek jalan raya dibina di Johor terutama sekali di kawasan Iskandar Malaysia. Lengkung pugak jalan raya tersebut merupakan jenis lengkung pugak *sag* seperti yang ditunjukkan dalam **Rajah Q2** di mana G1 ialah -1.75% dan G2 ialah +2.25%. Panjang lengkung ialah 1200 meter dan ketinggian titik persilangan lengkung pugak ialah 591 meter.

(i) Analisis dan rekabentukkan lengkung pugak bagi setiap sela 100 meter.

(ii) Analisis dan tentukan paras ketinggian pada titik minimum.

(16 markah)

S3 (a) Terangkan secara ringkas istilah keselamatan jalan raya berikut:

(i) Pengurangan kemalangan.
(ii) Pencegahan kemalangan.

(5 markah)

(b) Pejalan kaki dan penunggang motorsikal ialah pengguna jalan raya yang dikategorikan sebagai Pengguna Jalan Raya Tidak Kebal. Senaraikan **TIGA (3)** aktiviti atau tindakan yang boleh dijalankan di dalam program keselamatan untuk kedua-dua pengguna jalan raya ini.

(6 markah)

(c) **Rajah Q3(c)** menunjukkan kawasan titik hitam di Jalan Bunga Raya. Berdasarkan gambarajah perlanggaran dan persekitaran jalan:

(i) Kenalpasti masalah-masalah.
(ii) Cadangkan langkah mengatasi untuk setiap masalah di **S3(c)(i).**

(6 markah)

(d) Kemalangan jalan raya di Malaysia pada tahun 1996 ialah sebanyak 189,109 kes manakala pada tahun 2005 ialah sebanyak 328,268 kes. Oleh itu, peningkatan yang telah berlaku ialah sebanyak 74 peratus dan majoritinya adalah perlanggaran depan.

Sebagai seorang Jurutera Trafik, cadangkan satu penyelesaian yang paling sesuai untuk mengatasi jenis perlanggaran tersebut.

(2 markah)

(e) Audit Keselamatan Jalan Raya Tahap 5 telah dijalankan di Jalan Merang-Kuala Besut yang baru dibina dan gambar-gambar daripada audit adalah seperti yang ditunjukkan dalam **Rajah Q3(e).**

(i) Tunjukkan kekurangan daripada aspek keselamatan jalan raya di atas rajah tersebut.
(ii) Berikan ulasan sebagai juruaudit keselamatan jalan raya berdasarkan apa yang ditunjukkan.

(6 markah)

S4 (a) **Jadual 2** menunjukkan bilangan penggunaan kenderaan persendirian yang besar di Kuala Lumpur. Berdasarkan jadual, bincangkan perkongsian mod di antara kenderaan persendirian dan pengangkutan awam.

Jadual 2: Perkongsian mod pengangkutan di Kuala Lumpur (2003)

Mod	Peratus (%)
Motosikal	13
Kereta	71
Bas	6
Rel	10

(6 markah)

(b) Cadangkan bagaimana perkongsian mod pengangkutan dapat diseimbangkan melalui berikut:

(i) Parkir.
(ii) Lorong bas.

(6 markah)

(c) ITIS telah dilancarkan di Lembah Klang untuk kelancaran aliran lalu lintas. ITIS disokong oleh dua sistem utama iaitu Sistem Pengurusan Lalu Lintas Termaju (ATMS) dan Sistem Maklumat Perjalanan Termaju (ATIS).

(i) Terangkan fungsi ATMS dan ATIS.
(ii) Bincangkan **EMPAT (4)** kelebihan ITIS.

(9 markah)

(d) Berdasarkan ilustrasi skematik jaringan jalan bandar dalam **Rajah Q4**, senaraikan jenis jalan yang berlabel A, B, C dan D.

(4 markah)

S5 (a) Senaraikan **EMPAT (4)** prinsip rekabentuk persimpangan yang selamat.

(4 markah)

(b) Diberi dalam **Rajah Q5** data aliran trafik dan aliran tepu bagi setiap arah masukan di persimpangan lampu isyarat yang terdiri dari masa kuning, a = 3s , semua merah, R = 2s dan masa tindakbalas pemandu, l = 2s. Rekabentuk kawalan lalu lintas masa tetap untuk persimpangan sedia ada seperti yang ditunjukkan dalam **Rajah Q5**.

(21 markah)

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APPENDIX I

Name: _____ Matrix Num.: _____

Table 1: Spot Speed Data

Speed Class (km/h)	Upper limit (km/h)	Class midpoint, x (km/h)	Number of Vehicles, f	Percentage of Vehicles	Cumulative Percentage of Vehicles	fx
44 – 49	49.5	46.5	0			
50 – 55	55.5	52.5	13			
56 – 61	61.5	58.5	16			
62 – 67	67.5	64.5	22			
68 – 73	73.5	70.5	28			
74 – 79	79.5	76.5	26			
80 – 85	85.5	82.5	31			
86 – 91	91.5	88.5	18			
92 – 97	97.5	94.5	9			
98 – 103	103.5	100.5	9			
104 – 109	109.5	106.5	7			
110 – 115	115.5	112.5	4			
116 – 121	121.5	118.5	5			
122 – 127	127.5	124.5	2			

Note *Please attach this table together with your answer script sheet.*

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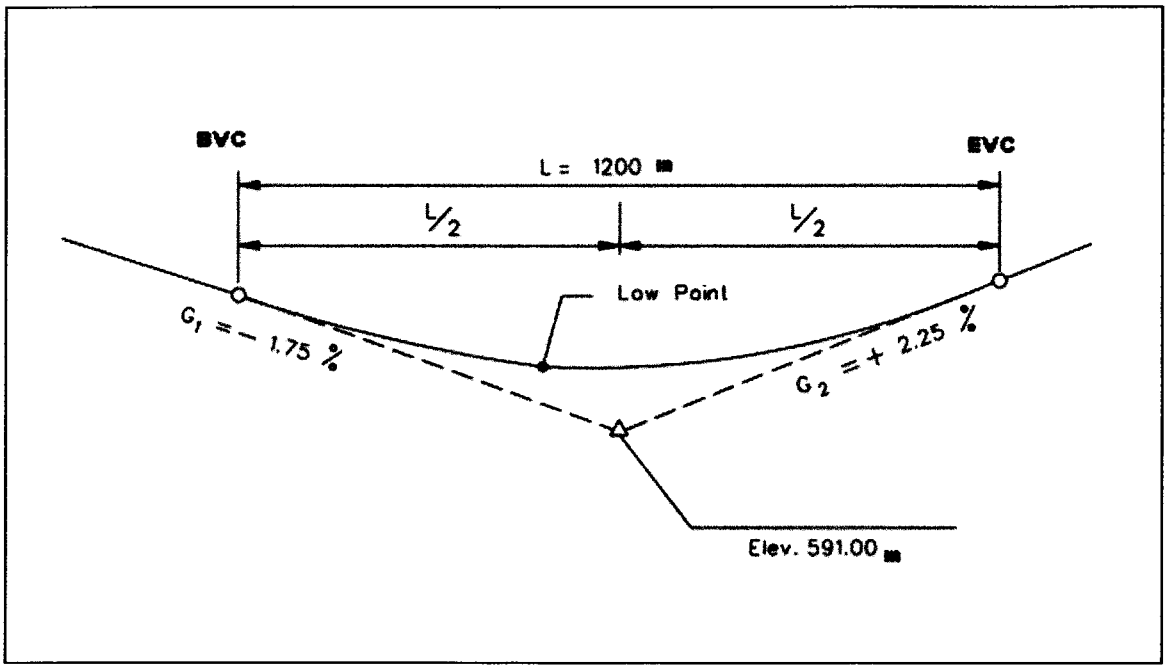

FIGURE Q2

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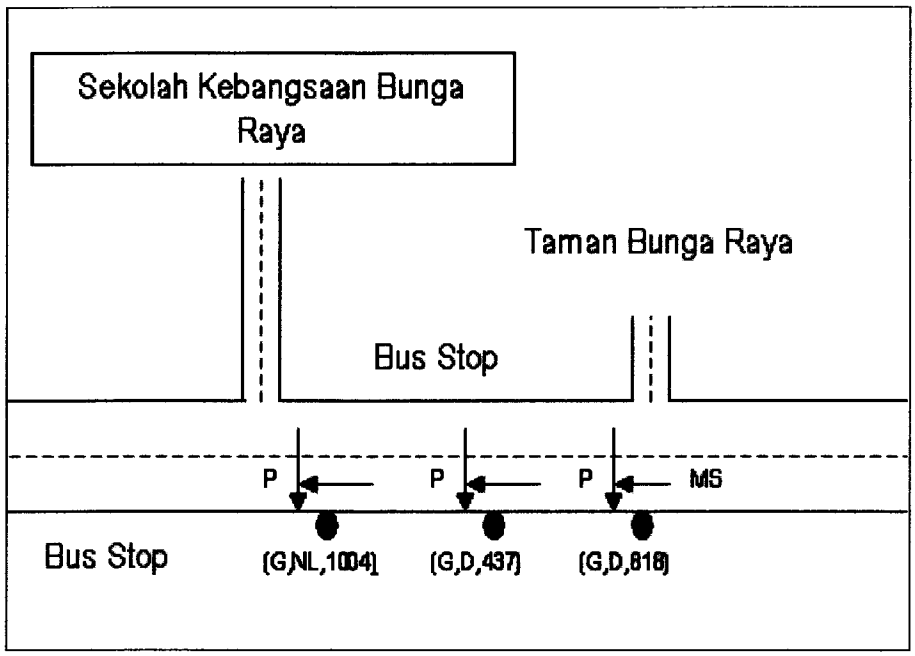

FIGURE Q3(c)

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APPENDIX II

Name : _____ Matrix Num. : _____

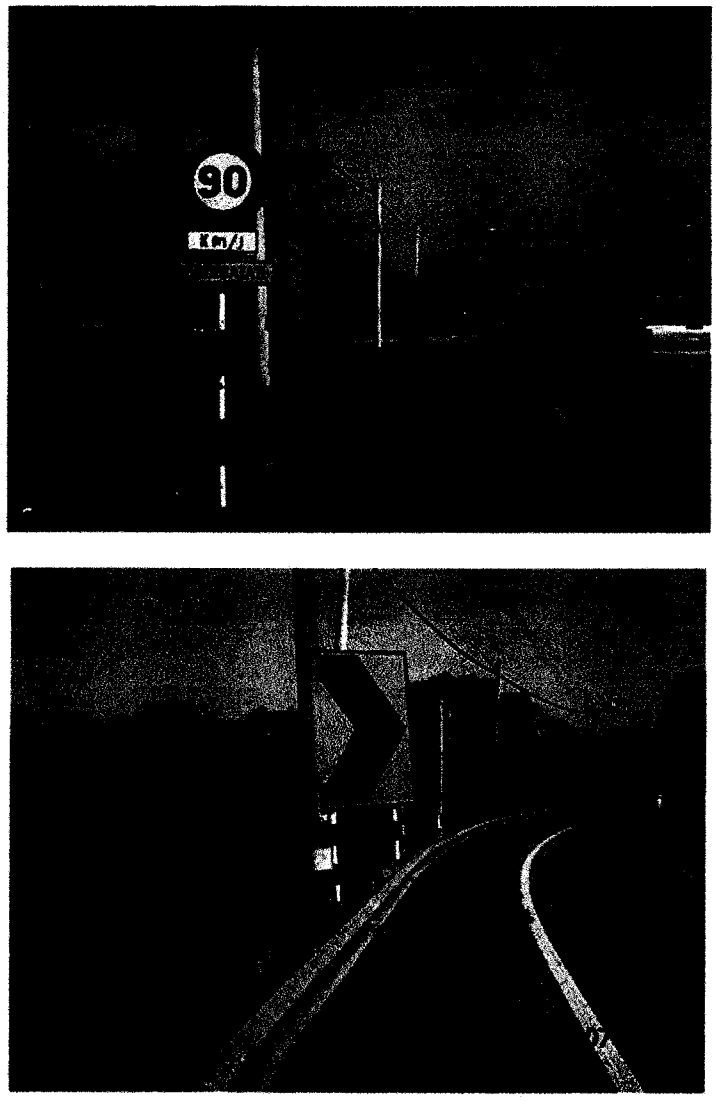

FIGURE Q3(e)

***Note:** Please separate and attach this attachment in your answer script book.*

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APPENDIX III

Name : _____ Matrix Num. : _____

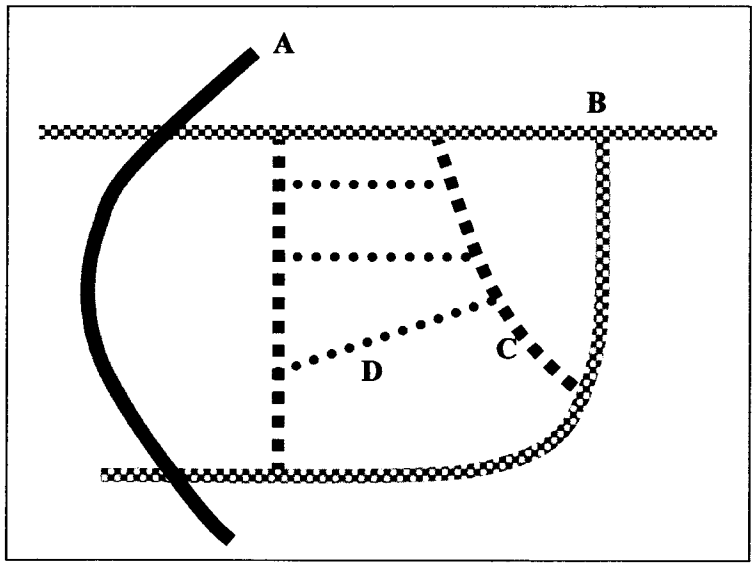

FIGURE Q4

Answer:

A = _____

B = _____

C = _____

D = _____

**Note: Please separate and attach this attachment in your answer script book.*

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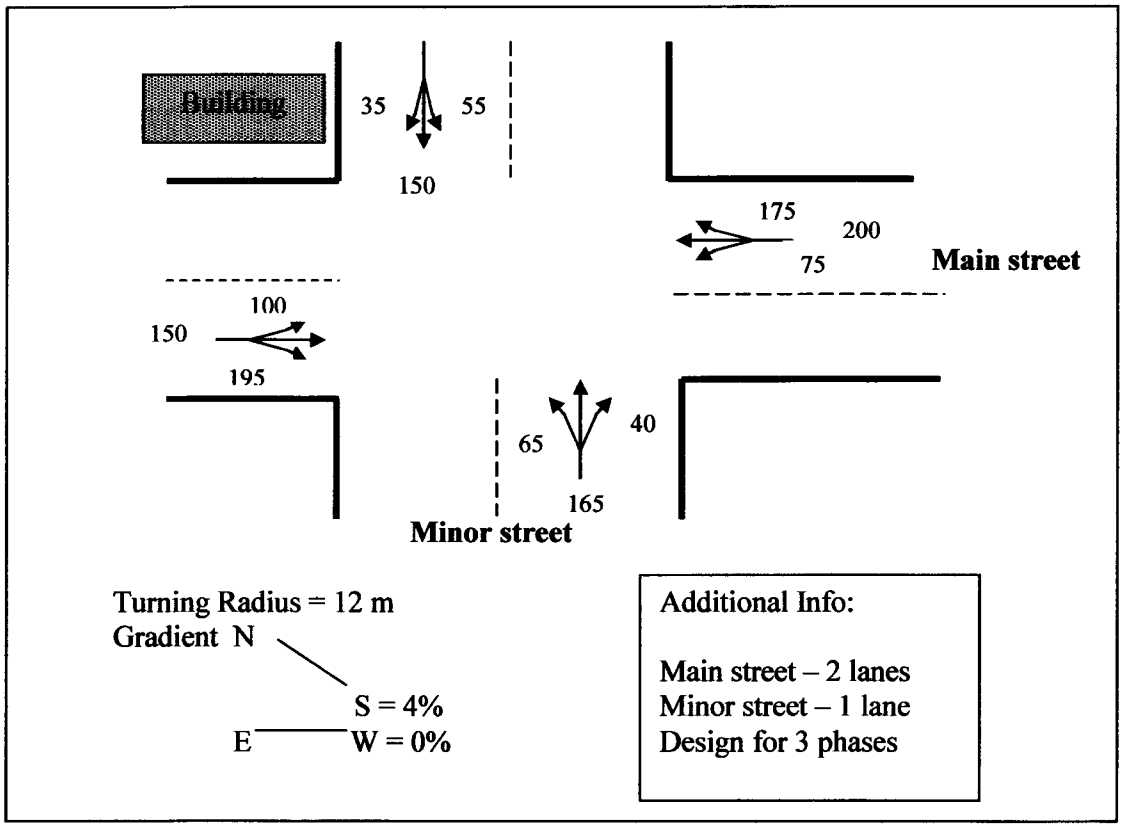

Approach	Saturation Flow, S (pcu/hr)
North	1965
South	1965
West	1915
East	1915

FIGURE Q5

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Table 3: Longitudinal Coefficient of Friction Proposed for Certain Design Speeds

Design speed, *V* (km/hr)	30	40	50	60	70	80	90	100	110	120
Coefficient of friction, *f*	0.40	0.38	0.35	0.33	0.31	0.30	0.30	0.29	0.28	0.28

Table 4: Side Friction Factor

Design speed (km/h)	**Side friction factor, f**
30	0.17
40	0.17
50	0.16
60	0.15
70	0.14
80	0.14
90	0.13
100	0.12

Table 5: Desired minimum horizontal curve radius (JKR)

Design Speed (km/h)	**Minimum Radius (m)**	
	e = 6%	**e = 10%**
120	710	570
100	465	375
80	280	230
60	150	125
50	100	85
40	60	50
30	35	30
20	15	15

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Table 6: Stopping Sight Distance (AASHTO)

Design Speed (km/h)	Stopping Sight Distance (m)		
	AASHTO 2000	AASHTO 1994	
	Design	Desirable	Minimum
30	35	29.6	29.6
40	50	44.4	44.4
50	65	62.8	57.4
60	85	84.6	74.3
70	105	110.8	94.1
80	130	139.4	112.8
90	160	168.7	131.2
100	185	205.0	157.0

Table 7: Relationship between effective lane width and saturation flow

Width, W (m)	Saturation Flow, F (pcu/hr)
3.00	1845
3.25	1860
3.50	1885
3.75	1915
4.00	1965
4.25	2075
4.50	2210
4.75	2375
5.00	2560
5.25	2760

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Table 8: Correction factor for the effect of gradient, Fg

Correction Factor, Fg	Description
0.85	for upward slope of 5%
0.88	for upward slope of 4%
0.91	for upward slope of 3%
0.94	for upward slope of 2%
0.97	for upward slope of 1%
1.00	for level grade
1.03	for downward slope of 1%
1.06	for downward slope of 2%
1.09	for downward slope of 3%
1.12	for downward slope of 4%
1.15	for downward slope of 5%

Table 9: Correction Factor for the effect of turning radius, Ft

Correction Factor, Ft	Description
0.85	for turning radius $R \leq 10$ m
0.90	for turning radius where $10 \text{ m} < R < 15$ m
0.96	for turning radius where $15 \text{ m} < R < 30$ m

Table 10: Correction factors for turning traffic

% 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

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Table 11: Conversion factors to pcu

Vehicle type	Equivalent pcu value
Passenger cars	1.00
Motorcycles	0.33
Light Vans	1.75
Medium lorries	1.75
Heavy lorries	2.25
Buses	2.25

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Formulae:

$$SSD = 0.278tV + \frac{V^2}{254\left(f \pm \frac{n}{100}\right)}$$

$$S_A = \frac{Vt}{3.6} + \frac{1}{2a}\left(\frac{V}{3.6}\right)^2 \qquad S_D = 0.278V(J + t_a)$$

$$R_{min} = \frac{V^2}{127(e_{max} + f_{max})}$$

$$v_s = \frac{nL}{\sum_{i=1}^{n} t_i} \qquad v_t = = \frac{\sum_{i=1}^{n} v_i}{n}$$

$$d_1 = v_s \times t_1 \qquad d_2 = 2s + v_s\sqrt{4s/a} \qquad s = 0.7v_s + 6$$

$$d_3 = v_0 \times t_3 \qquad d_4 = 2/3\, d_2$$

$S \leq L$: $M = \frac{S^2}{8R}$

$S > L$: $M = \frac{L(2S - L)}{8R}$

$$L = \frac{\Delta}{180^\circ}\pi R \qquad SSD = \frac{\Delta_s}{180^\circ}\pi R_v \qquad M = R\left(1 - \cos\frac{\Delta}{2}\right)$$

$$M_s = R_v\left(1 - \cos\frac{\Delta_s}{2}\right) \qquad M_s = R_v\left[1 - \cos\left(\frac{90SSD}{\pi R_v}\right)\right]$$

$$l = 2R_v\sin(\Delta_s/2)$$

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$$S \leq L: \qquad L_{min} = \frac{AS^2}{(\sqrt{2h_1} + \sqrt{2h_2})^2}$$

$$S > L: \qquad L_{min} = 2S - \frac{2(\sqrt{h_1} + \sqrt{h_2})^2}{A}$$

$$S \leq L: \qquad L_{min} = \frac{AS^2}{\left(8D - \frac{8(h_1 + h_2)}{2}\right)}$$

$$S > L: \qquad L_{min} = 2S - \frac{\left(8D - \frac{8(h_1 + h_2)}{2}\right)}{A}$$

$$\frac{\Sigma fx}{n} \qquad L + \left[\frac{\left(\frac{n}{2}\right) - f_L}{f_m}\right] \times C \qquad \sqrt{\frac{\Sigma fx^2}{n-1} - \frac{(\Sigma fx)^2}{n(n-1)}}$$

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$$\theta_s = \frac{5729.578L_s}{200R_c}$$

$$p = Y_s - R_c(1-\cos\theta_s)$$

$$\phi_c = \frac{\theta_s}{3} - \frac{0.0031\theta_s^{\,3}}{3600}$$

$$T_s = \left[(R_c + p)\tan\frac{\Delta}{2}\right] + k$$

$$\Delta_c = \Delta - 2\theta_s$$

$$E_s = \left[(R_c + p)\sec\frac{\Delta}{2}\right] - R_c$$

$$X_s = L_s\left(1 - \frac{\theta_s^{\,2}}{10} + \frac{\theta_s^{\,4}}{216} - \frac{\theta_s^{\,6}}{9360}\right)$$

$$S.T. = \frac{Y_s}{\sin\theta_s}$$

$$Y_s = L_s\left(\frac{\theta_s}{3} - \frac{\theta_s^{\,3}}{42} + \frac{\theta_s^{\,5}}{1320}\right)$$

$$L.T. = X_s - Y_s\cot\theta_s$$

$$L.C. = \frac{X_s}{\cos\phi_c} = \sqrt{X_s^{\,2} + Y_s^{\,2}}$$

$$L_c = \Delta_c R_c$$

$$k = X_s - R_c\sin\theta_s$$

$$\text{Gradient of superelevated pavement} = \frac{a}{L_s}$$

$$D = \frac{5486.4}{\pi R}$$

$$L = \frac{\pi}{180^\circ}\Delta R$$

$$T = R\tan\Delta/2$$

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

$$y_{min/max} = \text{elevation @ BVC} \pm Y_{min/max}$$

$$\text{where} \quad Y_{min/max} = \frac{G_1 x_{min/max}}{100} - \frac{A}{200L}(x_{min/max})^2$$

$$LP_n = G_1 * (\text{Interval}) + LP_{n-1}$$

$$y_n = 4e\left(\frac{x}{L}\right)^2, \quad \text{where} \quad e = \frac{AL}{800}$$

$$L_{x_n} = LP_n - y_n$$

$$S = 525\ W$$

$$LW = 1.7 - 0.9\frac{(Z - 7.6)}{k}$$

$$S_{adj} = S \times Fg \times Ft \times Fr \times Fl$$

$$y = q / S$$

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

$$I = R + a$$

$$a = \frac{V}{2A} + \frac{W + L}{V}$$

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

$$g_1 + g_2 + \ldots + g_n = C_o - L$$

$$\frac{g_1}{g_2} = \frac{y_1}{y_2}$$

$$g_n = \frac{Y_n}{Y}(C_o - L)$$

$$G = g + \ell + R$$

$$K = G - a - R$$
$$= g + \ell - a$$

$$pcu_{(future)} = pcu_{(present)} \times (1 + r)^n$$

$$G_{ped} = 5 + (W/1.22) - I$$