# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2012/2013

| | | |
|---|---|---|
| COURSE NAME | : | TRAFFIC ENGINEERING & SAFETY |
| COURSE CODE | : | BFC 3082 / 32302 |
| PROGRAMME | : | 3 BFF |
| EXAMINATION DATE | : | DECEMBER 2012/JANUARY 2013 |
| DURATION | : | 2 HOURS |
| INSTRUCTION | : | ANSWER **FOUR (4)** QUESTIONS ONLY. |

THIS QUESTION PAPER CONSISTS OF **FOURTEEN (14)** PAGES

**Q1** (a) Explain the key characteristics of differences between interrupted and uninterrupted flow in traffic studies. Illustrate both answers.

(4 marks)

(b) The traffic flow study was conducted along Parit Raja-Ayer Hitam highway in year 2010. During data collection, the mean free speed was observed to be 60 km/h near zero density. The corresponding jam density is 140 veh/km. Assume that the relationship of speed-density is linear.

(i) Write down speed-density and flow-density equations.
(ii) Draw the v-k, v-q and q-k diagrams and indicate the critical values.
(iii) Compute speed and density corresponding to a flow of 1000 veh/hr.

(21 marks)

**Q2** (a) Describe the following terms in horizontal alignment design.

(i) Spiral.
(ii) Superelevation.

(4 marks)

(b) A vertical curve joining +3 percent and −4 percent grade is to be designed for 120 km/hr and the tangents intersect at an elevation of 76.20 metres. Use L = KA.

(i) Calculate the location of maximum point on the curve.
(ii) Analyze the location of BVC.
(iii) Determine the crest vertical curve for interval of 40 metres.

(21 marks)

**Q3** (a) Environment is one of the factors which can contribute to road accident. Discuss **THREE (3)** elements that should be considered in this factor.

(6 marks)

(b) Discuss the 3E approaches in reducing the number of road accidents.

(9 marks)

(c) Describe **FIVE (5)** stages involved in Road Safety Audit.

(10 marks)

**Q4** (a) Discuss ways in the following strategies which can control and manage the usage of parking spaces on main road.

(i) Policy.
(ii) Technology level.

(15 marks)

(b) Based on your answers in **Q4(a),** give your opinion of potential future developments that beneficial for further improvements in Malaysia.

(10 marks)

**Q5** (a) Give **THREE (3)** advantages of the traffic signal control.

(3 marks)

(b) **Figure Q5** shows peak demand flows (in pcu/hr) for an intersection. Given amber time, a = 3s , all red interval, R = 2s and driver reaction time, ($l$ = 2s for Phase 1 and Phase 2) and ($l$ = 3s for Phase 3-South).

(i) Calculate the saturation flow (S).
(ii) Calculate the optimum cycle time.
(iii) Determine the effective green time, actual green time and controller setting time.
(iv) Sketch the timing schedule.

(22 marks)

**- END OF QUESTION -**

**S1** (a) Terangkan ciri-ciri utama perbezaan di antara aliran terganggu dan tak terganggu dalam kajian lalulintas. Gunakan contoh untuk menjelaskan jawapan anda.

(4 markah)

(b) Kajian aliran lalulintas telah dijalankan di sepanjang lebuh raya Parit Raja - Ayer Hitam pada tahun 2010. Semasa pengumpulan data, purata halaju bebas yang dicerap adalah 60 km/j menghampiri ketumpatan sifar. Ketumpatan kesesakan yang sepadan adalah 140 kend/km. Andaikan bahawa hubungan laju-ketumpatan adalah linear.

(i) Tuliskan persamaan laju-ketumpatan dan aliran-ketumpatan.
(ii) Lakarkan rajah v-k, v-q dan q-k dan tunjukkan nilai kritikal.
(iii) Kirakan kelajuan dan ketumpatan sepadan dengan aliran 1000 kend/jam.

(21 markah)

**S2** (a) Terangkan terma-terma berikut dalam rekabentuk penjajaran mengufuk.

(i) Pilin.
(ii) Sendengan.

(4 markah)

(b) Sebuah lengkung tegak yang menyambung cerun +3 peratus dan −4 peratus akan direkabentuk untuk 120 km/jam dan tangen bersilang pada aras ketinggian 76.20 meter. Gunakan L = KA.

(i) Kirakan lokasi titik maksimum pada lengkung tersebut.
(ii) Analisiskan lokasi BVC.
(iii) Tentukan lengkung tegak puncak untuk setiap sela 40 meter.

(21 markah)

**S3** (a) Persekitaran merupakan salah satu faktor yang menyebabkan berlakunya kemalangan jalan raya. Bincangkan **TIGA (3)** elemen yang perlu dipertimbangkan dalam faktor tersebut.

(6 markah)

(b) Bincangkan pendekatan 3E dalam mengurangkan bilangan kemalangan jalan raya.

(9 markah)

(c) Terangkan **LIMA (5)** tahap yang terlibat dalam Audit Keselamatan Jalan Raya.

(10 markah)

**S4** (a) Bincangkan kaedah dalam strategi yang berikut untuk mengawal dan mengurus penggunaan ruang tempat letak kenderaan di jalan utama.

(i) Polisi.
(ii) Peringkat teknologi.

(15 markah)

(b) Berdasarkan jawapan anda di **S4(a)**, berikan pendapat anda mengenai perkembangan masa hadapan yang mempunyai potensi untuk penambahbaikan di Malaysia.

(10 markah)

**S5** (a) Berikan **TIGA (3)** kebaikan pemasangan lampu isyarat.

(3 markah)

(b) **Rajah Q5** menunjukkan data aliran puncak (dalam unit kenderaan penumpang/jam) di persimpangan lampu isyarat. Diberi masa kuning, a = 3s, semua merah, R = 2s dan masa tindakbalas pemandu, ($l$ = 2s untuk fasa 1 dan fasa 2) dan ($l$ = 3s untuk fasa 3-Selatan).

(i) Kirakan aliran tepu (S).
(ii) Kirakan masa kitar optimum.
(iii) Tentukan masa hijau berkesan, masa hijau sebenar dan masa kawalan set.
(iv) Lakarkan gambarajah masa.

(22 markah)

**- SOALAN TAMAT -**

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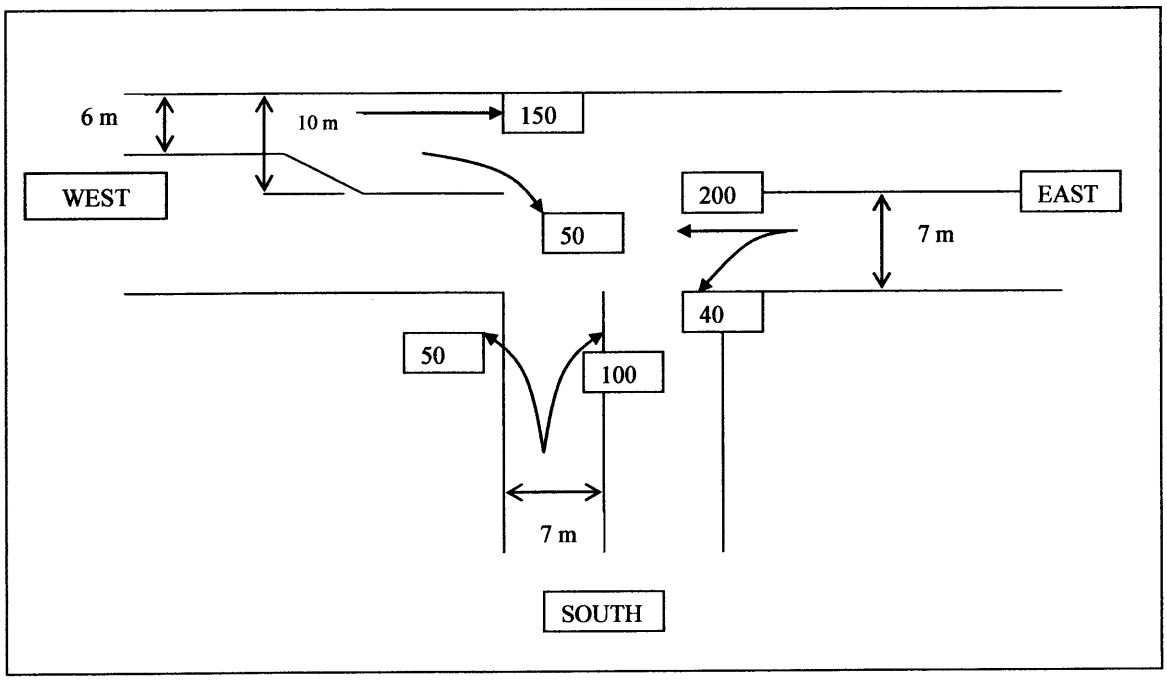


**FIGURE Q5**

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Table 1: Suggested minimum K values for vertical curves

| Design Speed (km/hr) | 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 |

Table 2: 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 3: 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 4: 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 m < R < 15 m |
| 0.96 | for turning radius where 15 m < R < 30 m |

Table 5: 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 **6:** 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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***Formula:***

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\frac{\Sigma fx}{n}$$

$$L + \left[\frac{\left(\frac{n}{2}\right) - f_L}{f_m}\right] \times C$$

$$\sqrt{\frac{\Sigma fx^2}{n-1} - \frac{(\Sigma fx)^2}{n(n-1)}}$$

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

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

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

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

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

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

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

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

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

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

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

$$L_c = \Delta_c R_c$$

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

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

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

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

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

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

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

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

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

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

$APW = \sum w_i n_i$, where, $w_i$ = weigtage point of $i$ type of accident
$n_i$ = no. of accident of $i$ type of accident