UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: December 2020

Module Number: CE5306

Module Name: Traffic and Transportation Engineering (C-18)

[Three Hours]

[Answer all questions. Each question carries **TWELVE** marks]
All Standard Notations denote their regular meanings

Q1. a) Traffic signs are the primary way of communication between the road Engineer and the user. It is important to have consistency in the traffic signs. Name the manual used in designing traffic control devices. Giving sketches and indicating colour schemes used, briefly explain the used of three types of traffic control devices which are defined in the above stated manual.

[3.0 Marks]

b) Compare and contrast the traffic signs and traffic signals.

[2.0 Marks]

c) Identification traffic conflicts is the first step in designing an effective traffic control device. Only considering merging, diverging, and crossing conflicts, draw the traffic conflict diagram for the staggered intersection (Consider all roads to be carrying traffic in both directions in one lane each) and determine the number of traffic conflicts by type.

[4.0 Marks]

d) In order to fulfil the intended use traffic control devices needs to be fulfilled certain requirements. Name three requirements of a traffic control device and briefly explain them.

[3.0 Marks]

Q2. a) An approach of a certain intersection receives a flowrate of 620 veh/h. The saturation flow rate for the approach is estimated to be 2,300 veh/hg, with a 120 s cycle length, and 55 s of effective green.

i. Determine what type of delay
ii. Determine the delay of vehicles during the off-peak period.

[3.0 Marks]

b) The above stated approach (in section Q2. a) experiences sudden increase in vehicle flow rate for a one-hour period. During this time, vehicles arrive at a rate of 1,640 veh/h. If the other parameters remain same determine the following

i. type of delay experienced by the approach;
ii. average control delay per vehicle for the full hour;
iii. average control delay per vehicle for the first and the last 15 minutes periods of the peak period.

[4.0 Marks]

c) An approach to a signalized intersection has two lanes, permitted right-turn phasing, 15% right -turning vehicles, and a right -turn equivalent factor of 4.5. The saturation headway for through vehicles is 2.1 s/veh. Determine the equivalent saturation flow rate and headway for all vehicles on this approach.

[2.0 Marks]

d) Determine the start-up lost time and the saturation flow rate if the time taken to clear N vehicles through an intersection will be given by

$$T = 2.04 + 2.35N$$

[3.0 Marks]

Q3. a) Turning movement counts carried at an intersection are shown in Figure Q3-1. Stating any assumptions clearly answer the following questions based on data provided.

i. Check for the right-turns that need protection.
ii. Draw the phase diagram
iii. Convert volumes to through vehicle equivalents
(Use Table Q3-1 in page no 7 of 7))

[6.0 Marks]

b) Determine the critical volumes for each phase by drawing the ring diagram.

[2.0 marks]

c) Assuming an Amber time of 4 s and All red time of 2 s determine the total lost time per phase

[1.0 Marks]

d) Determine the total desirable cycle length and the effective green time for each phase.

[1.0 Marks]

e) Signal system used in an intersection has a three-phases and a cycle length of 120 s. East-west direction (1 lane per direction) flow has a green time of 52 s, amber time of 5 s, all-red time of 3 s and a total lost time of 5 s. If a saturation headway of 1.11 s can be assumed for the mix of traffic at the intersection. Calculate the capacity of a west bound-lane group.

[2.0 Marks]

Q4. a) A short-time count at station 1 made on Tuesday showed a total of 420 vehicles entering from 9:00 am to 9:30 am, and 500 vehicles entering between 2:00 pm to 2:30 pm. Estimate the 12-hour flow (weekly average) at station 1, if the 12-hour counts at station "A" (the master station) made on same Tuesday showed 9,560 vehicles and if station "A" recorded the volumes of 410 vehicles between 9:00 – 9:30 am and 356 vehicles between 2:00 – 2:30 pm.

[3.0 Marks]

b) Data obtained in a long-term traffic volume count survey at a link in front of a private hospital 'A' is shown in Table Q4-1 and Table Q4-2. Determine the daily expansion factors and the monthly expansion factors for this location.

[3.0 Marks]

c) Due to non-availability of long-term traffic volume count surveys at links in front of three proposed developments 'B', 'C', and 'D', it was decided to use the long-term data obtained in Q4.b) as the master station for other proposed hospitals. One-hour counts were done at the proposed developments 'B', 'C', and 'D'. Assuming the hourly expansion factor 2:00-3:00 pm to be 14.320 and using the data shown in Table Q4- 3 determine the AADTs at links in front of three proposed hospitals 'B', 'C,' and 'D'.

[6.0 Marks]

Q5. a) Using neat sketches and examples explain the concept of "Air hub" with relation to air transportation

[3.0 Marks]

b) Explain the essential features of a BRT system.

[3.0 Marks]

c) Argue in favour or against the following statement about the LRT systems "LRT system should not be adopted in Sri Lanka because it cannot carry freight"

[3.0 Marks]

d) Explain the working principle of hyperloop giving advantages and disadvantages.

[3.0 Marks]

Figures, Tables and Equations

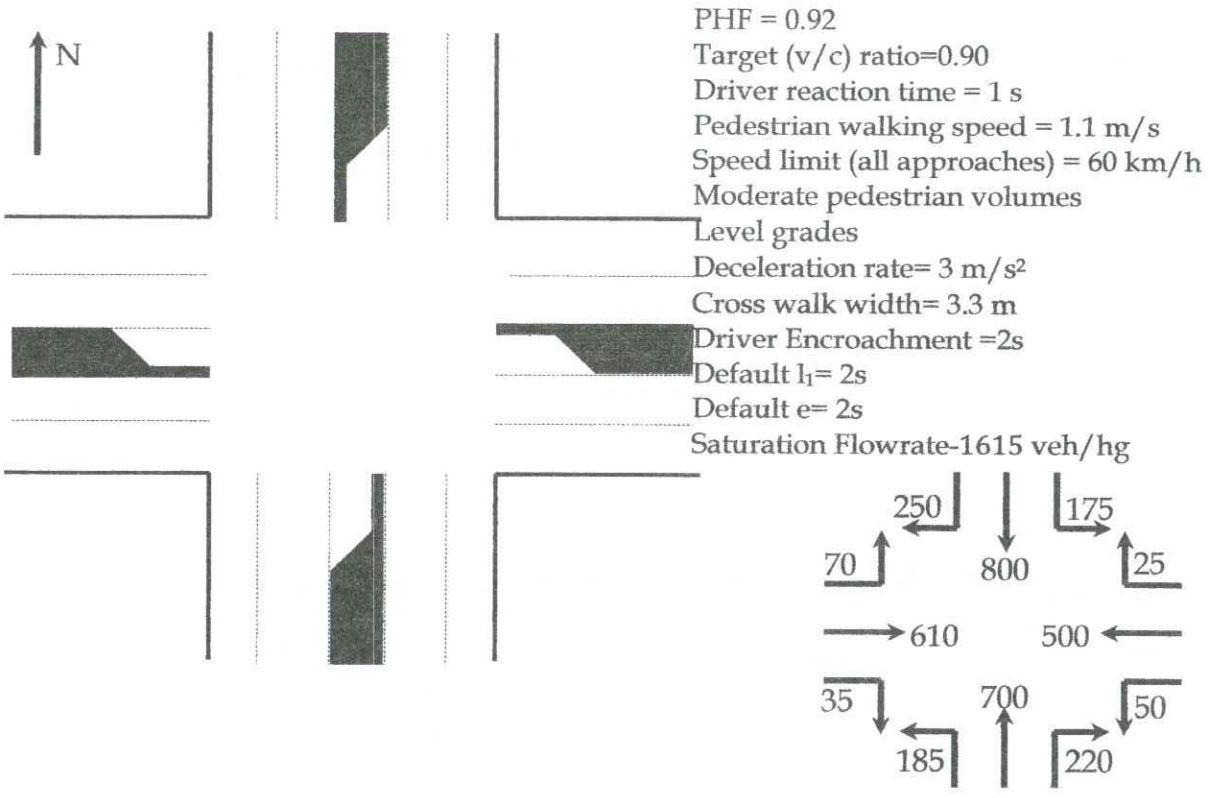

Figure Q3-1 Traffic Flow Details of an Intersection

Table Q3-1 (Please see the Page 7 of 7)

Table Q3-2 Adjustment for Right Turn Equivalence (TRB) E_{RT}

Opposing through plus left flows (vph)	Number of Lanes		
	1	2	3
0 – 199	1.1	1.1	1.1
200 – 399	2.5	2.0	1.8
400 – 599	5.0	3.0	2.5
600 – 799	10.0	5.0	4.0
800-999	13.0	8.0	6.0
1000-1199	15.0	13.0	10.0
≥1200	15.0	15.0	15.0
Adjustment for Right Turn Equivalence with protection = 1.05			

Table Q3-3 Left turning multiplicative factors for Pedestrians movements E_{LT}

Pedestrian flow per hour	Multiplicative Factor
None (0)	1.18
Low (50)	1.21
Moderate (200)	1.32
High (400)	1.52
Extreme (800)	2.14

Table Q4-1 AADT by day of a link in front of hospital 'A'

Day of the week	**AADT for the Day (Veh/Day)**
Monday	18,780
Tuesday	16,300
Wednesday	15,430
Thursday	16,300
Friday	19,285
Saturday	10,979
Sunday	5,890

Table Q4-2 AADT by month of a link in front of hospital 'A'

Month	AADT of Monthly (Veh/Day)
January	18,700
February	19,650
March	16,470
April	15,600
May	14,770
June	14,560
July	14,304
August	13,016
September	15,240
October	14,700
November	15,580
December	23,462

Table Q4-3 Traffic Flow Details of a link in front of School

Hospital	Day	Month	Traffic Volume (Veh/hour)
B	Monday	April	678
C	Tuesday	April	765
D	Wednesday	June	995

Equations

$$a = \frac{1}{n}\sum_{i=1}^{n} y_i - \frac{b}{n}\sum_{i=1}^{n} x_i = \bar{y} - b\,\bar{x}$$

$$b = \frac{\sum_{i=1}^{n} x_i y_i - \frac{1}{n}(\sum_{i=1}^{n} x_i)(\sum_{i=1}^{n} y_i)}{\sum_{i=1}^{n} x_i^2 - \frac{1}{n}(\sum_{i=1}^{n} x_i)^2}$$

$$R^2 = \frac{\sum_{i=1}^{n}(Y_i - \bar{y})^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2}$$

$$C_{des} = \frac{L}{1 - \sum_{i=1}^{p}\left(\frac{Y_i}{PHF \times \left(\frac{v}{c}\right)}\right)}$$

$$g_i = \frac{q_{ci}}{q_c} \times (C_{des} - L)$$

$$ar = \frac{P + L_v}{1.47 \times S_{85}}$$

$$q_{LT} \geq 200 \text{ veh/h}$$

$$q_{LT} \times \left(\frac{q_O}{N_O}\right) \geq 50{,}000$$

$$N = \left(\frac{Z_C \times \sigma}{E}\right)^2$$

$$\overline{T_S} = T_S + \frac{O_S - P_S}{V_S}$$

$$V_N = \frac{N_S + O_N - P_N}{T_N + T_S}$$

$$\frac{\Delta t_1}{\Delta t - \Delta t} = \frac{m - p}{q - p}$$

$$P(x) = \frac{(\lambda t)^x e^{-\lambda t}}{x!}$$

$$P(h \geq t) = e^{-\lambda(t-\tau)}$$

$$UD_o = 0.5C\left[1 - \frac{g}{C}\right]$$

$$OD = \frac{T_1 + T_2}{2} \times (X - 1)$$

$$UD = \frac{C}{2}\frac{\left[1 - \left(\frac{g_i}{C}\right)\right]^2}{\left[1 - \frac{q}{s}\right]}$$

$$q = U_f \times k - \frac{U_f}{k_j} \times k^2$$

$$q = c \times k \times \ln\left[\frac{k_j}{k}\right]$$

$$U = U_f - \frac{U_f}{k_j} \times k$$

$$U = c \times \ln\left[\frac{k_j}{k}\right]$$

$$L = \lambda \times W$$

$$L_q = \lambda \times W_q$$

$$W = W_q + \frac{1}{\mu}$$

$$L - L_q = \rho$$

$$\rho = \frac{\lambda}{\mu}$$

$$DEF = \frac{\text{Average total volume for week}}{\text{Average volume for particular day}}$$

$$MEF = \frac{AADT}{\text{ADT for particular month}}$$

$$HEF = \frac{\text{Total volume for 24hr period}}{\text{Volume for particular hour}}$$

(NOTE: Detach Table Q3-1 and attach it to answer script)

Index number: .....

Table Q3-1

Approach	*Movement*	*Volume (Veh/h)*	E_{RT} *or* E_{LT}	*Volume (tvu/h)*	*Lane group vol (tvu/h)*	*Vol/Lane (tvu/h)*
EB	R					
	T					
	L					
WB	R					
	T					
	L					
NB	R					
	T					
	L					
SB	R					
	T					
	L					