TRAFFIC SIMULATION AND MODELLING
ASSIGNMENT-5

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SOLUTION
Qn-1a:
Link list

Count: 39	No	Name	LinkBehavType	DisplayType	Level	NumLanes	Length2D
1	1		1: Urban (motorized)	1: Road gray	1: Base	1	183.702
2	2		1: Urban (motorized)	1: Road gray	1: Base	2	272.597
3	3		1: Urban (motorized)	1: Road gray	1: Base	1	216.197
4	4		1: Urban (motorized)	1: Road gray	1: Base	2	355.162
5	5		1: Urban (motorized)	1: Road gray	1: Base	1	235.738
6	6		1: Urban (motorized)	1: Road gray	1: Base	1	196.614
7	7		1: Urban (motorized)	1: Road gray	1: Base	1	137.410
8	8		1: Urban (motorized)	1: Road gray	1: Base	2	160.107
9	9		1: Urban (motorized)	1: Road gray	1: Base	2	159.804
10	10		1: Urban (motorized)	1: Road gray	1: Base	2	67.732
11	11		1: Urban (motorized)	1: Road gray	1: Base	1	85.468
12	12		1: Urban (motorized)	1: Road gray	1: Base	1	227.695
13	13		1: Urban (motorized)	1: Road gray	1: Base	2	145.528
14	14		1: Urban (motorized)	1: Road gray	1: Base	1	179.486
15	15		1: Urban (motorized)	1: Road gray	1: Base	3	239.438
16	16		1: Urban (motorized)	1: Road gray	1: Base	2	280.253
17	17		1: Urban (motorized)	1: Road gray	1: Base	2	241.751

Connector list

Count: 39	No	Name	LinkBehavType	DisplayType	Level	NumLanes	Length2D	IsConn	FromLink	ToLink	HasOvtLn
18	10000		1: Urban (motorized)	1: Road gray		1	63.155	☑	1	17	☐
19	10001		1: Urban (motorized)	1: Road gray		1	35.451	☑	12	1	☐
20	10002		1: Urban (motorized)	1: Road gray		1	91.384	☑	4	5	☐
21	10003		1: Urban (motorized)	1: Road gray		1	64.998	☑	4	6	☐
22	10004		1: Urban (motorized)	1: Road gray		2	51.519	☑	10	8	☐
23	10005		1: Urban (motorized)	1: Road gray		2	55.205	☑	10	9	☐
24	10006		1: Urban (motorized)	1: Road gray		1	37.581	☑	8	11	☐
25	10007		1: Urban (motorized)	1: Road gray		2	141.049	☑	2	17	☐
26	10008		1: Urban (motorized)	1: Road gray		1	59.707	☑	12	13	☐
27	10009		1: Urban (motorized)	1: Road gray		1	62.750	☑	12	13	☐
28	10010		1: Urban (motorized)	1: Road gray		2	125.689	☑	13	16	☐
29	10011		1: Urban (motorized)	1: Road gray		1	131.447	☑	12	7	☐
30	10012		1: Urban (motorized)	1: Road gray		1	27.166	☑	2	3	☐
31	10013		1: Urban (motorized)	1: Road gray		1	55.210	☑	5	7	☐
32	10014		1: Urban (motorized)	1: Road gray		2	132.320	☑	4	16	☐
33	10015		1: Urban (motorized)	1: Road gray		1	117.547	☑	6	15	☐
34	10016		1: Urban (motorized)	1: Road gray		1	72.036	☑	3	15	☐
35	10017		1: Urban (motorized)	1: Road gray		1	61.094	☑	2	14	☐
36	10018		1: Urban (motorized)	1: Road gray		2	132.022	☑	8	15	☐
37	10019		1: Urban (motorized)	1: Road gray		1	46.212	☑	11	16	☐
38	10020		1: Urban (motorized)	1: Road gray		2	108.967	☑	9	17	☐
39	10021		1: Urban (motorized)	1: Road gray		1	133.550	☑	14	7	☐

Vehicle information

Count: 5	No	Name	Link	Volume(0)	Volume(900)	Volume(1800)	Volume(2700)	VehComp(0)	VehComp(900)	VehComp(1800)	VehComp(2700)
1	2		10	282.0	282.0	282.0	282.0	1: Veh	1: Veh	1: Veh	1: Veh
2	3		4	164.0	164.0	164.0	164.0	1: Veh	1: Veh	1: Veh	1: Veh
3	4		12	682.0	682.0	682.0	682.0	1: Veh	1: Veh	1: Veh	1: Veh
4	5		2	135.0	135.0	135.0	135.0	1: Veh	1: Veh	1: Veh	1: Veh
5	6		15	0.0	0.0	0.0	0.0	1: Veh	1: Veh	1: Veh	1: Veh

Count: 7	No	Name	Category	Model2D3DDistr	ColorDistr1	OccupDistr	Capacity
1	100	Car	Car	10: Car	1: Default	1: Single Occupancy	0
2	200	HGV	HGV	20: HGV	1: Default		0
3	300	Bus	Bus	30: Bus	1: Default	1: Single Occupancy	110
4	400	Tram	Tram	40: Tram	1: Default	1: Single Occupancy	215
5	510	Man	Pedestrian	100: Man	101: Shirt Man		0
6	520	Woman	Pedestrian	200: Woman	201: Shirt Woman		0
7	600	Bike	Bike	60: Bike	101: Shirt Man		0

Qn-1b:
Link 15, 16, 17 are selected for vehicle travel time measurement.

Count: 3	SimRun	TimeInt	VehicleTravelTimeMeasurement	Vehs(All)	TravTm(All)	DistTrav(All)
1	3	0-600	1: link-17	9	3.67	220.77
2	3	0-600	2: link-15	37	4.15	232.53
3	3	0-600	3: link-16	39	4.83	267.90

Count: 3	No	Name	StartLink	StartPos	EndLink	EndPos	Dist
1	1	link-17	17	18.865	17	239.632	220.77
2	2	link-15	15	4.739	15	237.268	232.53
3	3	link-16	16	10.855	16	278.751	267.90

Qn-2:

GM-3 MODEL

$$\ddot{x}_{n+1}(t+\Delta t) = \frac{a_0}{(x_n(t) - x_{n+1}(t))} \left[\dot{x}_n(t) - \dot{x}_{n+1}(t)\right] \longrightarrow (1)$$

Consider $u = x_n(t) - x_{n+1}(t)$

$$\frac{du}{dt} = \dot{x}_n(t) - \dot{x}_{n+1}(t)$$

$$du = \dot{x}_n(t) - \dot{x}_{n+1}(t) \cdot dt$$

Integrating equ-1 w.r.t dt

$$(1) \longrightarrow \int \ddot{x}_{n+1}(t+\Delta t)\, dt = \int \frac{a_0}{x_n(t) - x_{n+1}(t)} \left[\dot{x}_n(t) - \dot{x}_{n+1}(t)\right] dt$$

$$\int \ddot{x}_{n+1} = a_0 \int \frac{du}{u}$$

$$\dot{x}_{n+1} = a_0 \ln(u) + c_1$$

$$\dot{x}_{n+1} = a_0 \ln\left[x_n(t) - x_{n+1}(t)\right] + c_1 \longrightarrow (2)$$

Substituting $M = \dot{x}_{n+1}$, $\left[x_n(t) - x_{n+1}(t)\right] = 1/K$

$$(2) \longrightarrow M = a_0 \ln(1/K) + c_1 \longrightarrow (3)$$

at $K = K_{jam}$, $M = 0$

$$(3) \longrightarrow 0 = a_0 \ln\left(\frac{1}{K_j}\right) + c_1$$

let $c_1 = a_0 \ln c_2$

$$a_0 \ln\left(\frac{1}{K_j}\right) + a_0 \ln c_2 = 0$$

$$\left(\frac{c_2}{K_j}\right) = 1 \quad \therefore \boxed{c_2 = K_j}$$

$$(3) \longrightarrow M = a_0 \ln\left(\frac{1}{K}\right) + a_0 \ln(K_j)$$

$$\therefore \boxed{M = a_0\left[\ln\left(\frac{K_j}{K}\right)\right]} \longrightarrow \text{GREENBERG'S EQUATION}$$

Qn-3:

$A(t)$: cumulative arrivals from 0 to t

$D(t)$: cumulative departures from 0 to t

Queue length at any time 't'

$$L(t) = A(t) - D(t)$$

∴ Total time spent by the vehicles (total waiting time)

$$W(t) = \int_0^t L(t)\,dt = \int_0^t (A(t) - D(t))\,dt$$

Average number of vehicles (average queue length)

$$\bar{L}(t) = \frac{W(t)}{t} \longrightarrow (1)$$

when the system begins and ends in an empty state, the average waiting time is,

$$\bar{W}(t) = \frac{W(t)}{A(t)} \longrightarrow (2)$$

from (1) and (2),

$$\bar{W}(t) \times A(t) = \bar{L}(t) \times t$$

$$\bar{L}(t) = \frac{A(t)}{t} \times \bar{W}(t) \longrightarrow \text{LITTLE'S LAW} \longrightarrow (1)$$

- $\bar{L}(t)$: Average number of vehicles
- $\frac{A(t)}{t}$: Arrival rate per unit time
- $\bar{W}(t)$: Average waiting time for a vehicle

$$Q = K \cdot V \longrightarrow (2)$$

- Q : volume / flow (vehicle/time)
- K : density (vehicle/distance)
- V : speed (distance/time)

Dividing equ → (1) by 'l - length of a segment' on both sides

$$(1) \Rightarrow \frac{\bar{L}(t)}{l} = \frac{A(t)}{t} \times \frac{\bar{W}(t)}{l}$$

- $\frac{\bar{L}(t)}{l}$: $\frac{\text{Average no. of vehicles}}{\text{distance}}$ → K
- $\frac{A(t)}{t}$: $\frac{\text{vehicle}}{\text{time}}$ → Q
- $\frac{\bar{W}(t)}{l}$: $\frac{\text{Average waiting time}}{\text{distance}}$ → $\frac{1}{V}$

$$K = Q \times \frac{1}{V}$$

$$\Rightarrow \boxed{Q = K \cdot V}$$