Bangladesh University of Engineering and Technology, Dhaka

CE 6507

Assignment 3
TRAFFIC SIGNAL DESIGN and SIGNAL SYNCHRONISATION

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Submitted to
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Assignment 3

Fig: SITES taken from GIS

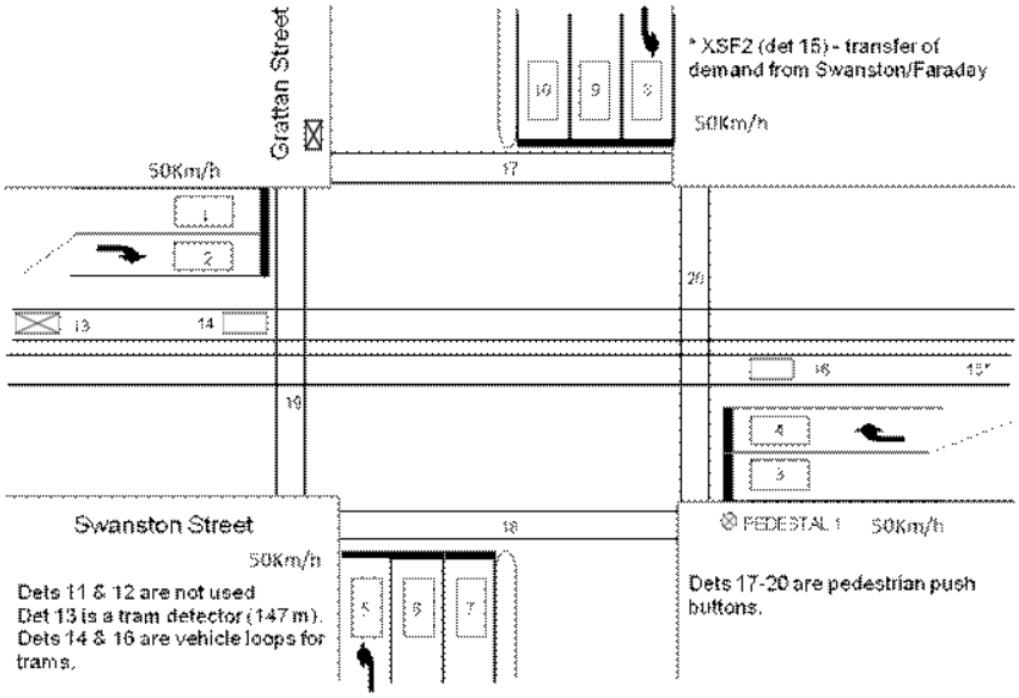
I have selected the following intersection to design the coordination system,

SITE NAME

A	B	C	D
SITE_4391	SITE_4395	SITE_4396	SITE_1029

Data Analysing for SITE 4391

DETECTOR MAP



From the VSDATA_20241227.csv file,
this column are found --

NB_SCATS_SITE	QT_INTERVAL_COUNT	NB_DETECTOR	V00	V01	V02							
V03	V04	V05	V06	V07	V08	V09	V10	V11	V12	V13	V14	V15
V16	V17	V18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28
V29	V30	V31	V32	V33	V34	V35	V36	V37	V38	V39	V40	V41
V42	V43	V44	V45	V46	V47	V48	V49	V50	V51	V52	V53	V54
V55	V56	V57	V58	V59	V60	V61	V62	V63	V64	V65	V66	V67
V68	V69	V70	V71	V72	V73	V74	V75	V76	V77	V78	V79	V80
V81	V82	V83	V84	V85	V86	V87	V88	V89	V90	V91	V92	V93
V94	V95	NM_REGION	CT_RECORDS	QT_VOLUME_24HOUR								
CT_ALARM_24HOUR												

Where V00 to V95 represent each 15 minute of traffic data.
From here peak 15 minute traffic volume of each detector can be found, then it can be multiplied by 4 to get hourly volume in peak hour. After analyzing -

Signal Design For SITE 4391

15 Min Peak Data Found Using datasheet -

	Left Turn	Through	Right Turn
North (UP)	20.00	13.00	50.00
Detector Number	8.00	9.00	10.00
South (DOWN)	17.00	12.00	40.00
Detector Number	5.00	6.00	7.00
East (RIGHT)		24.00	14.00
Detector Number		3.00	4.00
West (LEFT)		27.00	12.00
Detector Number		1.00	2.00

Then This is converted to hourly volume and 4 phase signal is desiged using this table,
Saturation is determined using this formula

$$Qs=1500+430\ W_d+10.5\ P_{nmv}-30\ P_{hv}-2\ P_{lt}-10P_{rt}$$

4 Phase Signal Design											
	Left Turn	Through	Right Turn	Critical Phase	Arrival Flow	Width	Left Turn %	Right Turn %	Heavy Veh %	Saturation (veh/h)	Veh/Sat
North (UP)	80.00	52.00	200.00	R & T	252.00	2.75	0.13	0.60	0.60	1500.00	0.17
South (DOWN)	68.00	48.00	160.00	R & T	208.00	2.75	0.16	0.58	0.60	1392.00	0.15
East (RIGHT)	0.00	96.00	56.00	R & T	152.00	2.75	0.00	0.37	0.70	1213.00	0.13
West (LEFT)	0.00	108.00	48.00	R & T	156.00	2.75	0.00	0.31	0.60	1100.00	0.14
										Sum(Y) =	0.58

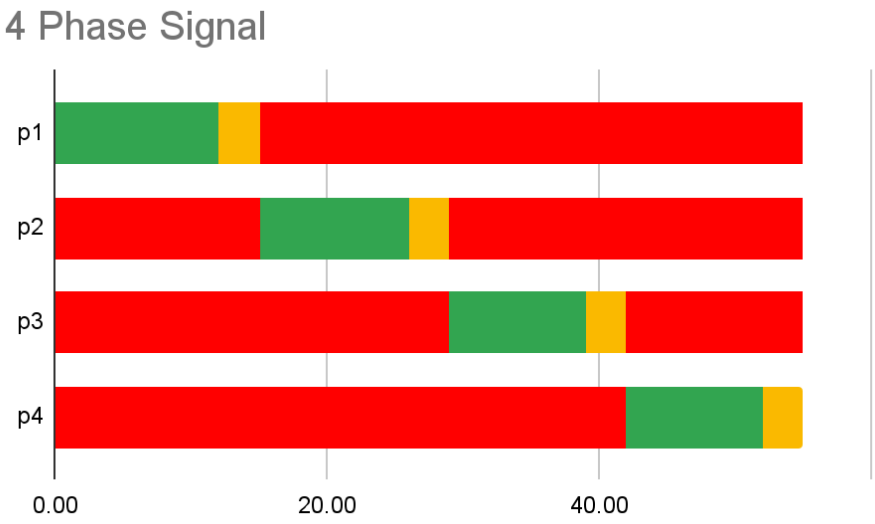
Signal Design:

	Y =	0.58			
Optimum Cycle Time	C0 =	55.00		Amber Time(s)	3.00
Total Effective Green Time	Gte = (Co-L)=	43.00		Total Lost Time (L),s =	12.00
Amber Period	A =	3.00			

Average vehicular delay is determined using this formula-

$$d = \frac{c(1-\lambda)^2}{2(1-\lambda x)} + \frac{x^2}{2q(1-x)} - 0.65\left(\frac{c}{q^2}\right)^{\frac{1}{3}} x^{(2+5\lambda)}$$

SITE_4391	Veh/Sat	Phase	Effective Green Time	x	Lamda	Average Vehicular delay	Total Delay
	Y (v/s)		Ge			d, sec	hrs
North	0.17	p1	12.00	0.17	0.22	17.45	73.28
South	0.15	p2	11.00	0.15	0.20	18.14	62.89
East	0.13	p3	10.00	0.13	0.18	18.84	47.72
West	0.14	p4	10.00	0.14	0.18	18.90	49.13



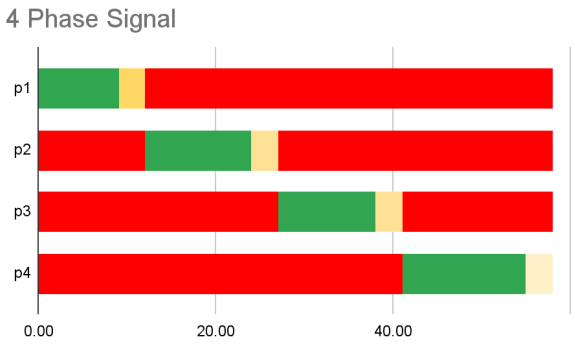
Similarly the signal design is done for the other three intersections.

Signal Design For SITE 4395

4 Phase Signal Design for SITE 4395											
	Left Turn	Through	Right Turn	Critical Phase	Arrival Flow	Width	Left Turn %	Right Turn %	Heavy Veh %	Saturation (veh/h)	Veh/Sat
North (UP)	36.00	112.00	36.00	R & T	148.00	3.75	0.09	0.20	0.60	1250.00	0.12
South (DOWN)	48.00	140.00	48.00	R & T	188.00	3.75	0.11	0.20	0.60	1200.00	0.16
East (RIGHT)	40.00	124.00	40.00	R & T	164.00	3.75	0.09	0.20	0.40	1150.00	0.14
West (LEFT)	52.00	152.00	52.00	R & T	204.00	3.75	0.20	0.20	0.40	1100.00	0.19
										Sum(Y) =	0.60

	Y =	0.60			
Optimum Cycle Time	C0 =	58.00		Amber Time(s)	3.00
Total Effective Green Time	Gte = (Co-L)=	46.00		Total Lost Time (L),s =	12.00
Amber Period	A =	3.00			

SITE_4395	Veh/Sat	Phase	Effective Green Time	x	Lamda	Average Vehicular delay	Total Delay
	Y (v/s)		Ge			d, sec	hrs
North	0.12	p1	9.00	0.12	0.16	21.09	52.01
South	0.16	p2	12.00	0.16	0.21	18.85	59.07
East	0.14	p3	11.00	0.14	0.19	19.57	53.50
West	0.19	p4	14.00	0.19	0.24	17.47	59.40

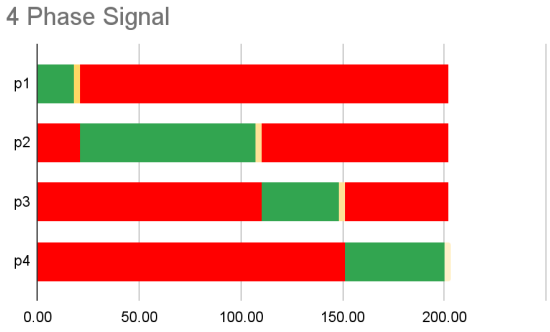


Signal Design For SITE 4396

4 Phase Signal Design For SITE 4396											
	Left Turn	Through	Right Turn	Critical Phase	Arrival Flow	Width	Left Turn %	Right Turn %	Heavy Veh %	Saturation (veh/h)	Veh/Sat
North (UP)	128.00	88.00	60.00	R & T	148.00	2.75	0.13	0.22	0.60	1800.00	0.08
South (DOWN)	108.00	360.00	240.00	R & T	600.00	2.75	0.09	0.34	0.60	1500.00	0.40
East (RIGHT)	272.00	148.00	100.00	R & T	248.00	2.75	0.25	0.19	0.40	1400.00	0.18
West (LEFT)	280.00	164.00	108.00	R & T	272.00	2.75	0.51	0.20	0.40	1200.00	0.23
										Sum(Y) =	0.89

	Y =	0.89			
Optimum Cycle Time	C0 =	202.00		Amber Time(s)	3.00
Total Effective Green Time	Gte = (Co-L)=	190.00		Total Lost Time (L),s =	12.00
Amber Period	A =	3.00			

SITE_4396	Veh/Sat	Phase	Effective Green Time	x	Lamda	Average Vehicular delay	Total Delay
	Y (v/s)		Ge			d, sec	hrs
North	0.08	p1	18.00	0.08	0.09	84.42	208.24
South	0.40	p2	86.00	0.40	0.43	40.14	401.43
East	0.18	p3	38.00	0.18	0.19	68.87	284.66
West	0.23	p4	49.00	0.23	0.24	61.31	277.96

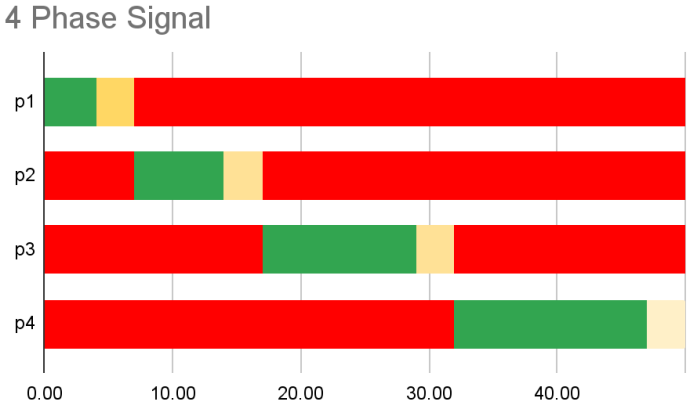


Signal Design For SITE 1029

4 Phase Signal Design FOR site 1029											
	Left Turn	Through	Right Turn	Critical Phase	Arrival Flow	Width	Left Turn %	Right Turn %	Heavy Veh %	Saturation (veh/h)	Veh/Sat
North (UP)	32.00	60.00	28.00	R & T	88.00	2.75	0.11	0.23	0.60	1392.00	0.06
South (DOWN)	48.00	80.00	40.00	R & T	120.00	2.75	0.13	0.24	0.60	1200.00	0.10
East (RIGHT)	36.00	120.00	60.00	R & T	180.00	2.75	0.07	0.28	0.40	1100.00	0.16
West (LEFT)	56.00	200.00	56.00	R & T	256.00	2.75	0.18	0.18	0.40	1200.00	0.21
										Sum(Y) =	0.54

	Y =	0.54			
Optimum Cycle Time	C0 =	50.00		Amber Time(s)	3.00
Total Effective Green Time	Gte = (Co-L)=	38.00		Total Lost Time (L),s =	12.00
Amber Period	A =	3.00			

SITE_1029	Veh/Sat	Phase	Effective Green Time	x	Lamda	Average Vehicular delay	Total Delay
	Y (v/s)		Ge			d, sec	hrs
North	0.06	p1	4.00	0.06	0.08	21.27	31.19
South	0.10	p2	7.00	0.10	0.14	18.75	37.51
East	0.16	p3	12.00	0.16	0.24	15.03	45.09
West	0.21	p4	15.00	0.21	0.30	13.09	55.84



Coordination System

- Cycle time is needed to be adjusted to ensure all four intersections run at the same cycle time.

- The largest cycle time among the intersections is used for all signals. This ensures no intersection becomes oversaturated.

From the above signal design -

Largest cycle (s)		202.00

Using this cycle time, signals were redesigned to achieve synchronization and ensure smooth flow across all four sites.

And,

Avg Speed=	50	km/h

Based On Largest Cycle time, Signal are redesigned,

SITE_4391	Veh/Sat	Phase	Effective Green Time
	Y (v/s)		Ge
North	0.17	p1	55.00
South	0.15	p2	49.00
East	0.13	p3	41.00
West	0.14	p4	46.00

SITE_4395	Veh/Sat	Phase	Effective Green Time
	Y (v/s)		Ge
North	0.12	p1	37.00
South	0.16	p2	49.00
East	0.14	p3	45.00
West	0.19	p4	58.00

SITE_4396	Veh/Sat	Phase	Effective Green Time
	Y (v/s)		Ge
North	0.08	p1	18.00
South	0.40	p2	86.00
East	0.18	p3	38.00
West	0.23	p4	49.00

SITE_1029	Veh/Sat	Phase	Effective Green Time
	Y (v/s)		Ge
North	0.06	p1	22.00
South	0.10	p2	35.00
East	0.16	p3	58.00
West	0.21	p4	75.00

Now to do the coordination -

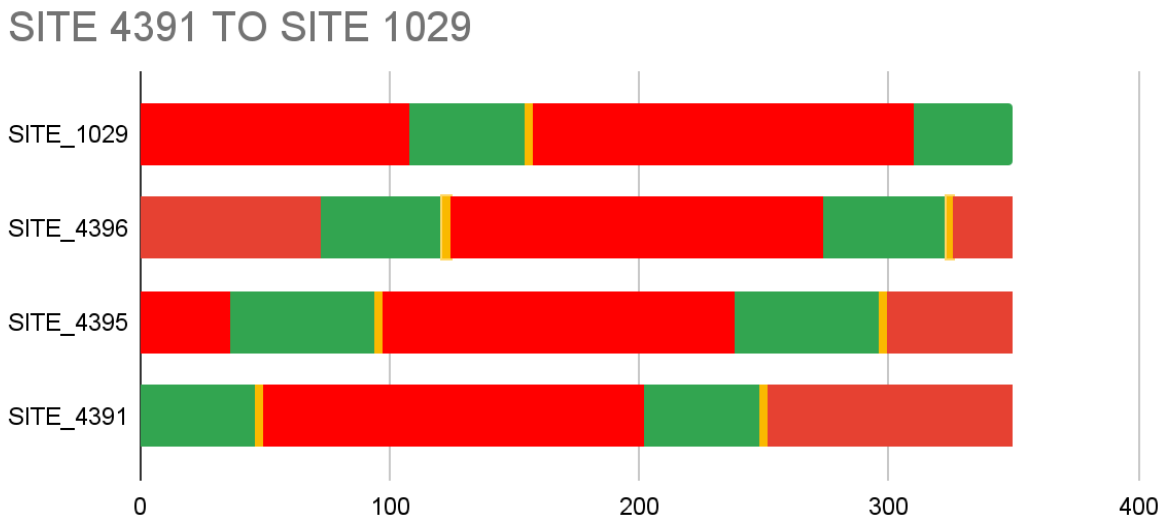
SITE_4391 to SITE_1029

Now for vehicle want to travel For SITE_4391 to SITE_1029 -

From	To	Distance (km)	Time(s)	Travel Time From First Position (s)
SITE_4391	SITE_4395	0.5	36	36
SITE_4395	SITE_4396	0.5	36	72
SITE_4396	SITE_1029	0.5	36	108

For SITE_4391 to SITE_1029 (East Side) West approach should be on green time (WEST TO EAST) . p4

	Travel TIme(s)	Offset	Cycle Time	Green (G)	Amber	Red	(TT-Offset)/Cycle	Remarks	Rest Green
SITE_4391	0	0	202.00	46.00	3	153.00	0	OK	46.00
SITE_4395	36	36	202.00	58.00	3	141.00	0	OK	58.00
SITE_4396	72	72	202.00	49.00	3	150.00	0	OK	49.00
SITE_1029	108	108	202.00	75.00	3	124.00	0	OK	75.00
BandWidth (s)		46.00							

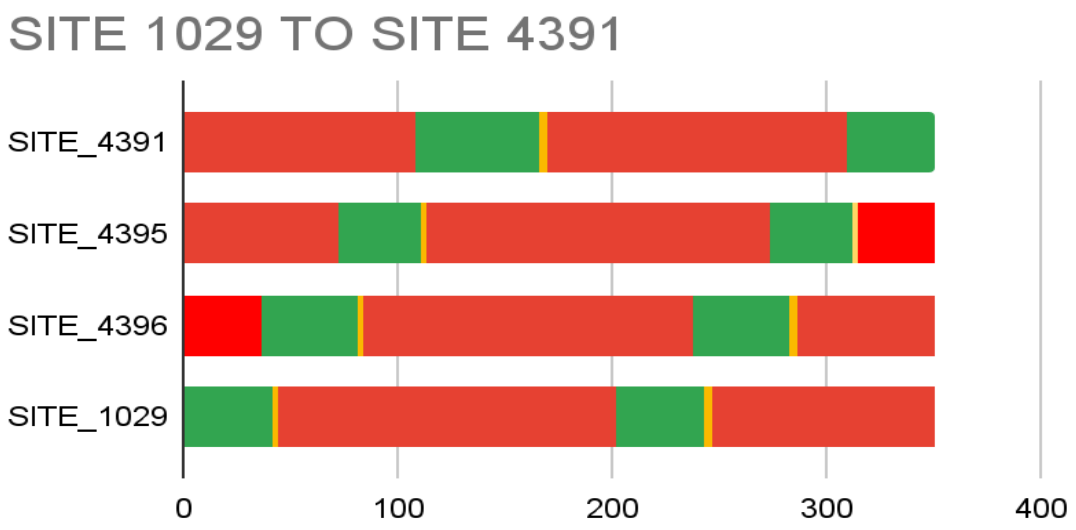


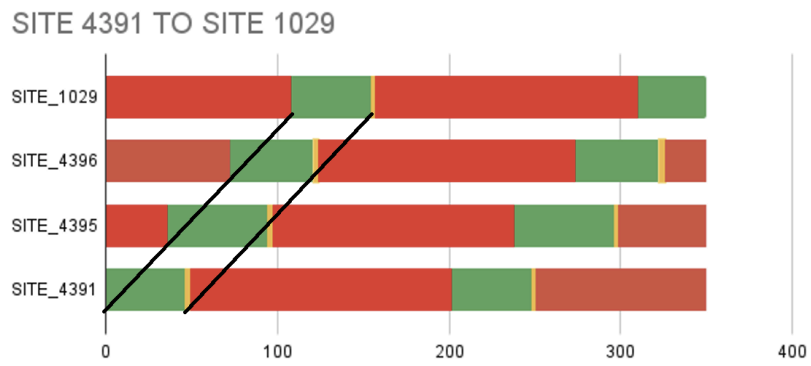
SITE_1029 to SITE_4391

Now for vehicle want to travel For SITE_1029 to SITE_4391-

	From	To	Distance (km)	Time(s)	Travel Time From First Position (s)
	SITE_1029	SITE_4396	0.5	36	36
	SITE_4396	SITE_4395	0.5	36	72
	SITE_4395	SITE_4391	0.5	36	108

For SITE_1029 to SITE_4391 (East Side) East approach should be on green time (East to West) . p3									
	Travel TIme(s)	Offset	Cycle Time	Green (G)	Amber	Red	(TT-Offset)/Cycle	Remarks	Rest Green
SITE_1029	0	0	202.00	41.00	3	158.00	0	OK	41.00
SITE_4396	36	36	202.00	45.00	3	154.00	0	OK	45.00
SITE_4395	72	72	202.00	38.00	3	161.00	0	OK	38.00
SITE_4391	108	108	202.00	58.00	3	141.00	0	OK	58.00
BandWidth (s)		38.00							





SITE_4391 → SITE_1029 (East to West)

Phases aligned such that westward approaches are green upon vehicle arrival.

Offset setup ensures a bandwidth of 46 seconds for this direction.

Cycle Time = 202

Bandwidth Efficiency

= 100 * 46/ 202 = 22.77%

SITE_1029 → SITE_4391 (West to East)

Phases aligned such that eastward approaches are green upon vehicle arrival.

Offset setup ensures a bandwidth of 38 seconds for this direction.

Cycle Time = 202

Bandwidth Efficiency

= 100 * 38/202 = 18.81%

Comments on Bandwidth Efficiency and Operational Improvements:

Bandwidth Efficiency-
Eastbound efficiency (22.77%) is higher due to a wider green band, allowing more vehicles to pass without stopping. Westbound efficiency (18.81%) is slightly lower, but still demonstrates effective coordination. The green bands provide 46 seconds westward and 38 seconds eastward, ensuring a significant portion of traffic flows without stopping. A cycle length of 202 seconds supports synchronization but may lead to minor delays for approaches with less priority or lower demand.

Operational Improvements are happend like -

- Vehicles encounter fewer stops, improving average travel times.
- Continuous movement reduces fuel consumption and emissions.
- Predictable green phases reduce frustration and enhance driving experience.
- Synchronization supports smooth progression of platoons across intersections, reducing congestion.

Conclusion
Signal coordination among SITE 4391, SITE 4395, SITE 4396, and SITE 1029 has been successfully implemented. While bandwidth efficiency could be further optimized with increased cycle times or additional green time, the current setup provides a significant improvement in operational performance and traffic flow efficiency.