

Sub:	TRAFFIC ENGINEERING	Sub Code:	15CV561	Branch:	CIVIL	
Part A				MARKS	CO	RBT
1 (a)	Discuss briefly, fixed signal and vehicle actuated signals.		[04]	CO3	L2	
	Fixed signal+vehicle actuated signal (2+2)					
<p>Fixed time signal/ Pre-timed signals</p> <ul style="list-style-type: none"> ➤ Simplest automatic traffic signal ➤ Repeat the signal lights (Red, Green and amber) regularly or on predetermined basis. ➤ The major disadvantage is that the timings are not sensitive to traffic flow. So it cannot be used successfully for intersections with major and minor roads having different traffic intensities. <p>Traffic actuated signals: Here signal timings are altered based on traffic demand.</p> <p>This can be (i) <i>Semi-actuated</i> or (ii) <i>Fully actuated</i></p> <p>In <i>semiactuated traffic signal</i> the normal green period of any pahse can be extended for some more time based on the traffic volume. Detectors are installed at selected approaches for the intersection. In <i>fully actuated</i> signals detectors are connected to all approaches and they are synchronized so that the signal timings gets automatically readjusted based on the traffic. But it is costly to be provided in all intersections.</p>						
(b)	What is TDM? What are the direct and indirect methods of TDM?		[05]	CO5	L2	
	Definition+ direct methods and eg+indirect methods and eg (1+2+2)					
<p>TDM techniques are aimed at reducing the traffic flows, especially during the peak hour.</p> <p>Direct methods are the methods that can be directly quantified/ visible by the road user itself. Indirect methods are the methods which cannot be directly measured. Among the different techniques enlisted below, except road pricing all are direct methods.</p> <p>The different techniques adopted are</p> <ol style="list-style-type: none"> 1. Car pooling and other ride-sharing programmes 2. Peripheral parking 3. Chartered buses 4. Staggering of office hours 5. Internal shuttle service in CBD 6. Parking restraint 7. Road pricing 8. Entry fee 9. Priority for buses in traffic 						

10. Restrictions on entry of trucks during day-time.

(c) Establish the relationship between speed, flow and concentration using Green Shield's theory.

[06]

CO3

L3

Expression for optimum speed+ optimum density+optimum flow=2+2+2

Green shield (1934) analysed the data pertaining to a rural road in Ohio & found a linear relationship between speed & concentration of the following form

$$\bar{V}_s = \bar{V}_f - \left[\frac{\bar{V}_f}{D_j} \right] * D \quad \text{----- '1'}$$

\bar{V}_s = space mean speed

D = density / concentration

\bar{V}_f = free flow speed

D_j = Jamming concentration

Put $\bar{V}_s = \frac{q}{D}$ ----- '2'

Substitute '2' in '1'

$$\frac{q}{D} = \bar{V}_f - \left[\frac{\bar{V}_f}{D_j} \right] * D$$

$$q = \bar{V}_f * D - \left[\frac{\bar{V}_f}{D_j} \right] * D^2 \quad \text{----- '3'}$$

Also, $D = \frac{q}{\bar{V}_s}$ ----- '4'

$$\bar{V}_s = \bar{V}_f - \left[\frac{\bar{V}_f}{D_j} \right] * \frac{q}{\bar{V}_s}$$

$$\bar{V}_s^2 = \bar{V}_f * \bar{V}_s - \left[\frac{\bar{V}_f}{D_j} \right] * q$$

$$\left[\frac{\bar{V}_f}{D_j} \right] * q = \bar{V}_f * \bar{V}_s - \bar{V}_s^2$$

$$q = \frac{\bar{V}_f * \bar{V}_s}{\bar{V}_f} D_j - \frac{\bar{V}_s^2}{\bar{V}_f} D_j$$

$$q = \bar{V}_s D_j - \left[\frac{D_j}{\bar{V}_f} \right] \bar{V}_s^2 \quad \text{----- '5'}$$

Differentiating w.r.t concentration D

$$\frac{dq}{dk} = \bar{V}_f - 2 \frac{\bar{V}_f}{D_j} D$$

For flow to be maximum $\frac{dq}{dk} = 0$

$$\bar{V}_f = 2 \frac{\bar{V}_f}{D_j} D$$

or

$$D = \frac{D_j}{2} = D_0$$

Similarly to obtain speed at maximum flow; $\frac{dq}{d\bar{V}_s} = 0$

i.e. equation '2' differentiated & equated to zero

$$\frac{dq}{d\bar{V}_s} = D_j - \left[\frac{D_j}{\bar{V}_f} \right] * 2 * \bar{V}_s = 0$$

Or $D_j = \left[\frac{D_j}{\bar{V}_f} \right] * 2 * \bar{V}_s$

$$\bar{V}_s = \frac{\bar{V}_f}{2} = V_0$$

$$q_{max} = \bar{V}_s \text{ maximum} * D \text{ maximum}$$

$$q_{max} = \frac{\bar{V}_f}{2} \frac{D_j}{2} = \frac{\bar{V}_f * D_j}{4}$$

$$q_0 = \frac{\bar{V}_f * D_j}{4}$$

2 (a) Write a short note on traffic forecasting.

[04]

CO3

L2

Importance+factors+methods(1+2+1)

Need for traffic forecast: Scarcity of capital, Meet the traffic demand, Plan for future

Factors influencing traffic forecast

1. Population Growth/Migration
2. Land Use Changes
3. National/Regional Economy
4. Vehicle Operating Costs
5. Capacity Restraints
6. Induced Traffic due to new road facilities nearby
7. Vehicle ownership levels
8. Availability of alternative transport modes

Data for traffic prediction

1. **Time series data** consist of data that are collected, recorded, or observed over successive increments of time.
2. **Cross-sectional data** are observations collected at a single point in time.
3. **Panel data** are cross-sectional measurements that are repeated over time, such as yearly passengers carried for a sample of airlines.

Traffic forecast - Models

1. **Linear trend**
2. **Exponential Trend**
3. **Polynomial Trend Analysis**
4. **Forecasts based on Past Trends and Extrapolation**

(b) Discuss the role of road traffic in inducing air pollution. Also explain the different abatement measures for the same.

[05]

CO4

L2

Influence+abatement measures (2+3)

Air pollution

The fumes and smell emitted by other vehicles makes urban streets unpleasant. The major pollutants are

Carbondioxide, water vapour unburnt petrol, organic compounds produced from petrol, carbon monoxide, oxide of nitrogen, lead compounds, carbon particles (smoke).

Effect of pollutants

All the pollutants in small amount may not be detrimental. But over a long run, it can influence the well-being of residents.

Smoke contains carbon particles. Along with other compounds it can become detrimental. Smoke and fog can cause hazards to driving and irritation to eyes.

Abatement measures:

1. Improve vehicle design and maintenance.
2. Use of small cars instead of big ones.
3. Patronage of public transport system.
4. Use of alternative fuels and method of propulsion.
5. Restraining traffic through road pricing.
6. Stopping engines at the time of delays at intersections
7. Constructing bypasses and ring roads.
8. Staggering work hours
9. Institution of parking restraint.

(c) The average normal flow of traffic on cross roads A and B during design periods are 400 and 250 PCU/hr. The saturation flow values on these roads are estimated as 1250 and 1000 PCU/hr respectively. The all red time for pedestrian crossing is 12 sec.

[06]

CO3

L3

Cycle time -2
 Effective green time -2
 Phase diagram-2

Assume time lost due to starting delays = 2 sec /phase

Total lost time = $R+nl = 12+2 \times 2 = 16 \text{ sec.}$

$y_A = 400/1250 = 0.32$

$y_B = 250/1000 = 0.25$

$y = 0.32+0.25 = 0.57$

$C_0 = \text{Optimum cycle time} = 1.5L+51-y = 1.5 \times 16+51-0.57 = 67.44 \text{ sec} = 68 \text{ sec.}$

Effective green time = $68-16 = 52 \text{ sec}$

Effective green time for A = $0.32/0.57 \times 52 = 29 \text{ sec}$

Effective green time for B = $0.25/0.57 \times 52 = 23 \text{ sec}$



0	2		31	33		68
0			33	35	58	60
					68	68



3 (a) Explain the concept of road pricing. How does it help in travel demand management?

[04]

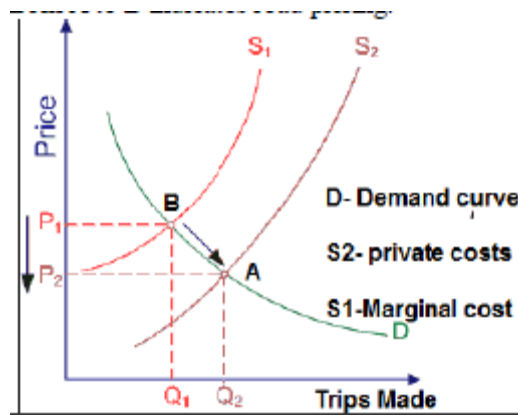
CO5

L2

Concept+importance -2+2

This is a method of road user taxation, charging the users of congested roads according to the time spent or distance travelled on those. The principle behind road pricing is that those who cause congestion or use the road in the congested period should be charge, thus giving the road user the choice of whether to make a journey or not.

The benefit the road user obtains from the journey is the price he is prepared to pay in order to make the journey. As the price gradually increases, a point will be reached when the trip-maker considers it as not worth performing the trip. This critical price would be his assessment of the benefit he/she derives from making the journey. At costs, less than critical price, he enjoys a net benefit called as Consumer surplus. Similarly the cost incurred in making the trip increases with the traffic volume which is called as private costs. On making any trip each road user creates an additional cost (marginal cost) in terms of congestion, parking etc. All these costs are shown in the figure below. Shift from A to B indicates road pricing.



(b) Discuss the different initiatives of Indian government towards promoting Public transport service
5 initiatives -5

[05]

CO4

L2

Public Transport consists of mass rapid transit (MRT); Para-transit and personalized PT. MRT, both rail and road based and including city bus is the backbone of city transport as they are the only modes that carry very large number of people using minimum space. Paratransit Modes i.e. tempos and mini buses supplement MRT in large cities and can be the main mode of PT in medium and small size cities.

Initiatives towards improving Public Transport services

1. Integrating land use and transport planning: Provide 50% of the cost of preparing comprehensive city transport plans and detailed project reports and reduce travel demand by better integration of land-use and transport planning.

2. Development of Suburban rail and metro systems. Cities like Delhi, Mumbai, Chennai, Kolkata, Bangalore, and Hyderabad have all been either expanding or improving their rail systems.

3. Privatization of bus services. Compared to the publicly owned, operated, and subsidized bus services in the same cities, the privately run services have higher productivity, lower costs, more passengers per bus, and higher revenues per bus km of service.

4. Improve motor vehicle technology and fuels. The most successful measure was the complete phasing out of lead in fuels. The allowable levels of sulphur and benzene in fuels were also reduced. Expert commission

of the Indian Government has

recommended successively adopting the increasingly stringent Euro II, Euro III, and Euro IV emission standards for all new cars, taxis, trucks, and buses, first in the largest cities and then for the entire country (Ministry of Petroleum and Natural Gas, 2002).

5. Jawaharlal Nehru National Urban Renewal Mission (JnNURM) is a reform-based mission with due emphasis on urban transport. This mission emphasises on the commuter comfort while traveling in public transport at reasonable cost.

6. Better cooperation among different transport agencies, departments, and ministries as well as better overall coordination of transport and land-use policies.

7. Central Government Initiatives like Atal Mission for Rejuvenation and Urban Transformation – AMRUT, Smart Cities Mission emphasises on increasing the amenity value of cities by switching on to public transport or constructing facilities for non-motorized transport e.g. walking and cycling.

(c) The speed and concentration of a vehicle in a traffic stream were observed and the following data are obtained. Find the linear regression equation for determining the speed and concentration.

[06] CO3 L3

K (VPH)	5	10	15	20	25	30	35	40	45	50
V (KMPH)	72	68	61	52	47	39	32	27	20	13

x	K (VPH)	5	10	15	20	25	30	35	40	45	50	275	27.5
y	V (KMPH)	72	68	61	52	47	39	32	27	20	13	431	43.1
xy		360	680	915	1040	1175	1170	1120	1080	900	650	9090	
(xi)2		25	100	225	400	625	900	1225	1600	2025	2500	9625	

$$\check{b} = \frac{\sum x_i y_i - n \bar{x} \bar{y}}{\sum x_i^2 - n (\bar{x})^2} = \frac{9090 - 10 \times 27.5 \times 43.1}{9625 - 10 \times 27.5 \times 27.5}$$

=

Part B

4 Write short notes on any two of the following
(a) VMS (b) One-way streets (c) Road side arboriculture

[10] CO4 CO5 L2

VMS-5 (Explanation-3+sketch 2)

One-way streets-5 (Advantages-3+Disadvantages-2)

Road side arboriculture-5(definition1+objectives and measures-4)

(a) **Variable message signs (VMS)** is an electronic traffic sign often used on roadways to give travellers information about special events. The information comes from a variety of traffic monitoring and surveillance systems. The content of the sign will change, dependent on the situation.

Advantages:

- It provides real-time information on special events on the oncoming road
- It improves motorists' route selection, reduce travel time, mitigate the severity and duration of

incidents and improve the performance of the transportation network.

- It warns driver of traffic congestion, accidents, incidents, roadwork zones, or speed limits on a specific highway segment.
- In urban areas, VMS provides parking guidance and information systems to guide drivers to available car parking spaces.
- It helps vehicles to take alternative routes, limit travel speed, warn of duration and location of the incidents or just inform of the traffic conditions.

Truck-mounted VMS (also called Portable Changeable Message Signs or PCMS) are sometimes dispatched by highway agencies to warn traffic of incidents such as accidents in areas where permanent VMS aren't available or near enough as a preventive measure for reducing secondary accidents.

(b) One-way streets are those where traffic movement is permitted only in one direction.

Advantages: 1. A reduction in the points of conflict: since opposing traffic flow is not there, head on collisions can be avoided and the number of conflict points is reduced. 2. Increased capacity: entire traffic in one direction, hence high capacity. 3. Increased speed: No opposing traffic, hence high speed. 4. Facilitating the operation of a progressive signal system: A smooth and safe traffic is ensured. 5. Improvement in parking facilities: Only one-side parking. This ensures more space for traffic movement. 6. Elimination of dazzle and head-on-collision

Disadvantages: 1. Though journey time decrease, actual distance to be covered increase. 2. The relocation of bus-stops due to one-way street regulation may cause the passengers to travel extra distance. 3. Excessive speed of vehicles may be a hazard to residential areas 4. One-way street regulation may become beneficial for some business and impart adverse effect to others based on accessibility. 5. Heavy traffic on one-way streets may affect the peace and tranquility of the area. 6. Initially confusion may set in during traffic operation. 7. Emergency vehicles may find it difficult to find gap in other lanes, since there is no traffic flow in opposite direction.

(c) **Arboriculture** means planting and growing of trees along road sides. It gives good appearance to the road. It also gives shade to the road users. This includes: → Flat side slopes in embankment and cut, rounded to blend to original surface. → Wide right of way and shoulders in rural highways. → Consistent and smooth horizontal and vertical alignments, pleasant views and parking places. → Suitable planting of trees and shrubs including its proper maintenance.

Objectives of Road Arboriculture:

- To provide beautification & natural landscape of roadsides
- To provide shade and comfort to the road users.
- To act as a wind breakers.

- To yield fruit and useful timber.
- To break the monotony of the road
- To protect the road surface from hot sun
- To prevent the movement of sand in desert area
- To absorb noise

5	Write short notes on any two of the following (a) Road markings (b) Signal co-ordination (c) Intelligent transport system	[10]	CO4 CO5	L2
	Road markings- 5(explnation3+sketches2) Signal co-ordination -5(definition1+types4) Intelligent transport System-5(definition1+advantages-2+methodologies2)			

Road markings are defined as lines, patterns, words or other devices, except signs, set into applied or attached to the carriageway or kerbs or to objects within or adjacent to the carriageway, for controlling, warning, guiding and informing the users.

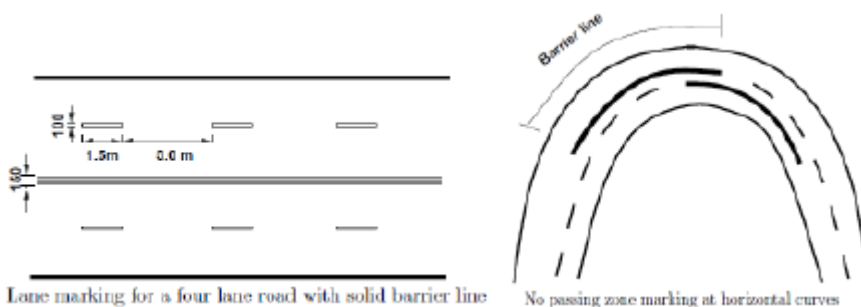
Functions

- To guide and control traffic on a highway.
- They supplement the function of traffic signs.
- The markings serve as a psychological barrier and signify the delineation of traffic path and its lateral clearance from traffic hazards for the safe movement of traffic.

The road markings are classified as

1. Longitudinal markings

- Longitudinal markings are provided for separating traffic flow in the same direction and the predominant color used is white.
- Yellow color is used to separate the traffic flow in opposite direction and also to separate the pavement edges.
- The lines can be either broken, solid or double solid.
- This include centre-line marking, traffic lane lines, no passing zones, warning lines, edge lines.



2. Transverse markings

- Transverse markings are marked across the direction of traffic.
- They are marked at intersections etc.
- The type of road marking for a particular intersection depends on several variables such as speed characteristics of traffic, availability of space etc.

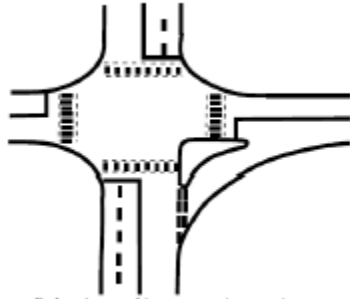
- They are classified as stop line, pedestrian crossings, directional arrows

3. Object markings

- Object markings are the markings made on physical obstructions like signal posts, pier etc that may cause serious hazard to the flow of traffic.

4. Word messages

- These are the markings made on road surface that convey information to guide, regulate, or warn the road user.



▪ Pedestrian marking near an intersection



Signal coordination is done when signals are closely spaced to enable vehicle in one predominant direction to get continuous green. This will reduce the delay and travel time in one direction and increases traffic flow.

Objectives:

- Reduce queue length
- Minimum overall delay to traffic streams
- Pass the maximum amount of traffic

Types:

1. Simultaneous system:

All the signals along a given street will display the same indication to the same traffic stream at the same time.

Division of cycle time is same at all intersections

2. Alternate system:

Consecutive traffic signal installations along a given road show contrary indications at the same time.

This permits the vehicles to travel one block in one half of the cycle time. It

brings about a certain measure of speed control since speeding drivers are stopped at each signal.

3. Simple progressive system:

Various signals along a street display green aspects in accordance with a time schedule to permit, as nearly as possible continuous operation of vehicles at a planned rate of motion. The offset period is so selected that there are minimum delays. But the offset is fixed throughout the day.

4. Flexible progressive system:

Cycle time and division at each signal is dependent upon the traffic.

It remains flashing or shut down during off peak hours

It's possible to vary offset.

Intelligent transportation systems (ITS) are advanced applications in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport.

Methodologies:

- Triangulation method– traffic data using mobile network
- Vehicle re-identification- using detectors using bluetooth or MAC identifying devices- useful for electronic toll booths
- GPS based methods - using in-vehicle GPS tracking vehicle
- Smartphone-based rich monitoring- using smart phones estimating traffic density

Services provided by ITS:

- Travel and traffic management
- Public transport operations

En-route transit information

- Electronic payment
- Advanced vehicle control and safety systems
- Emergency management

Signature of CI

Signature of CCI

Signature of HOD