

Module -5: Traffic Management:

Area Traffic Management System, Traffic System Management (TSM) with IRC standards, Traffic Regulatory Measures, Travel Demand Management (TDM), Direct and indirect methods, Congestion and parking pricing, All segregation methods- Coordination among different agencies, Intelligent Transport System for traffic management, enforcement and education.

1. Explain the importance and applications of ITS in traffic engineering

Intelligent Transportation Systems (ITS) is the application of computer, electronics, and communication technologies and management strategies in an integrated manner to provide traveler information to increase the safety and efficiency of the surface transportation systems. These systems involve vehicles, drivers, passengers, road operators, and managers all interacting with each other and the environment, and linking with the complex infrastructure systems to improve the safety and capacity of road systems.

ITS user services

Some of the user services offered by ITS are described as follows:

1. Travel and traffic management

The main objective of this group of services is to use real time information on the status of the transportation system to improve its efficiency and productivity and to mitigate the adverse environmental impacts of the system. This includes pre-trip information, enroute information, route guidance, route matching and information, traveller service information etc.

2. Public transportation operations

This group of service is concerned with improving the public transportation systems and encouraging their use. This includes services like real time public transit services and its maintenance, enroute information,

3. Electronic payment:

This user service allows travellers to pay for transportation services with a common electronic payment medium for different transportation modes and functions. Toll collection, transit fare payment, and parking payment are linked through a multi-modal multi-use electronic system. With an integrated payment system a traveller driving on a toll road, using parking lot would be able to use the same electronic device to pay toll, parking price and the transit fare.

4. Commercial vehicle operations: The aim is to improve the efficiency and safety of commercial vehicle operations including freight mobility, automated road side safety inspection, etc.

5. Advance vehicle control and safety systems: This user service aims to improve the safety of the transportation system by supplementing drivers' abilities to maintain vigilance and control of the vehicle by enhancing the crash avoidance capabilities of vehicles.

6. **Emergency management:** This includes emergency notification and personal security on the occurrence of an accident as well as emergency vehicle management.

7. **Information management:** This service is aimed to provide the functionality needed to store and archive the huge amounts of data being collected on a continuous basis by different ITS technologies.

8. **Maintenance and construction management:** This user service is aimed to provide the functionality needed for managing the fleets of maintenance vehicles, managing the roadway with regards to construction and maintenance and safe roadway operations.

ITS Architecture

The ITS Architecture provides a common framework for planning, defining, and integrating intelligent transportation systems. It specifies how the different ITS components would interact with each other to help solving transportation problems.

ITS Planning

ITS planning is to integrate ITS into the transportation planning process

2. What is TDM? What are the direct and indirect methods of TDM?

TDM techniques are aimed at reducing the traffic flows, especially during the peak hour.

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.

The different techniques adopted are

1. Car-pooling and other ride-sharing programmes- Leverage public and private funds to increase the use of ridesharing and other commuting options that reduce traffic congestion and improve air quality
2. Peripheral parking
3. Chartered buses - Subsidizing transit costs for employees or residents, workplace travel plans
4. Staggering of office hours - Flex-time work schedules with employers to reduce congestion at peak times
5. Internal shuttle service in CBD
6. Parking restraint - Requiring users of parking to pay the costs directly, as opposed to sharing the costs indirectly with others through increased rents and tax subsidies.
7. Road pricing- Time, distance and place (TDP) road pricing, where road users are charged based on when, where and how much they drive.
8. Congestion pricing during peak hours.
9. Entry fee
10. Priority for buses in traffic - Including and improving public transportation infrastructure, such as subway entrances, bus stops and routes.
11. Restrictions on entry of trucks during day-time.
12. Including or improving pedestrian-oriented design elements, such as short pedestrian crossings, wide sidewalks and street trees.

13. Bicycle-friendly facilities and environments, including secure bike storage areas and showers.
 14. Providing traveler information tools, including intelligent transportation system improvements, mobile and social applications, wayfinding tools, and other methods for promoting alternatives to single occupancy vehicle (SOV) modes
 15. Road space rationing or alternate-day travel by restricting travel based on license plate number, at certain times and places.
 16. Roadspace reallocation, aiming to re-balance provision between private cars which often predominate due to high spatial allocations for roadside parking, and for sustainable modes.
- 3. Explain the concept of road pricing. How does it help in travel demand management?**

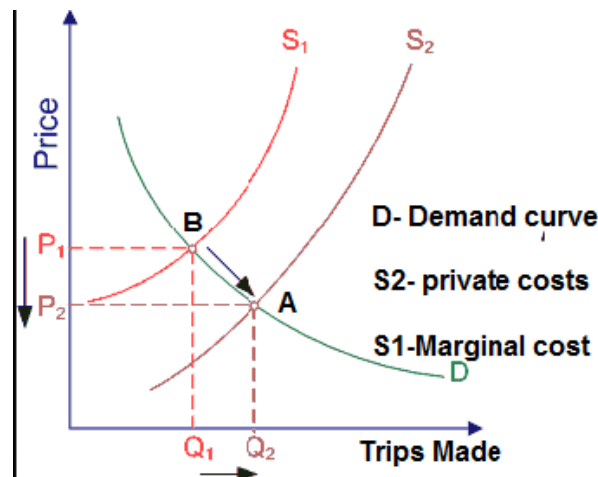
This is a method of road user taxation, charging the users of congested roads according to the time spent or distance travelled on those. The principle behind road pricing is that those who cause congestion or use the road in the congested period should be charge, thus giving the road user the choice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

Economic principles behind road pricing:

Journey costs are made up of

- (i) Private journey costs comprising of vehicle operating costs, value of individual's travel time.
- (ii) Congestion cost representing the cost imposed by road users on each other in terms of external delay
- (iii) Environmental costs
- (iv) Road maintenance costs

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.



4. Write short notes on One-way streets by highlighting its advantages and disadvantages.

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.

5. Comment on the state of art practice for “traffic management”.

The different methods of traffic management are

- (i) Restrictions on turning movements: Turning movements always create chaos at intersections. Among the turning movements, right turns are more crucial. In such cases providing an exclusive right turning phase in signal schemes or providing an early cut-off or late start in signal timings can eliminate such traffic problems.
- (ii) One-way streets: since the traffic flows only in one direction, capacity of the stretch increases and delays also will be reduced (Based on the marks this can be

elaborated). Proper signing is important as far as one way streets are concerned to ensure smooth and efficient traffic.

- (iii) Tidal flow operations: morning peak hours witness a huge traffic towards city centre, whereas in the evening it will be vice versa. Use of barricades such that more width of lane is available towards direction of movement is called as tidal flow/reverse flow operation.
- (iv) Exclusive bus-lanes: stoppage of public transport at mid block sections can create long queue. Hence, reservation of an exclusive lane for buses provides convenience and safety to embarking and alighting passengers without interrupting traffic flow.
- (v) Closing side streets: If there are many minor roads opening on main streets, it will cause interference to the main stream traffic. Hence, closing side streets, will reduce/eliminate that traffic chaos.

However, these are the conventional strategies of traffic management.

- Advanced Traffic Management System (ATMS) field is a primary subfield within the Intelligent Transportation System (ITS) domain. Here, real-time traffic data from cameras, speed sensors, etc. flows into a Transportation Management Center (TMC) where it is integrated and processed (e.g. for incident detection), and may result in actions taken (e.g. traffic routing, DMS messages) with the goal of improving traffic flow.
- Area traffic control is also an advanced traffic management system wherein signal timings are synchronized by a centralized system, so as to minimise delays and waiting times for the different arms of traffic.

6. Describe the significance of simulation studies in traffic engineering.

Traffic simulation or the simulation of transportation systems is the mathematical modelling of transportation systems (e.g., freeway junctions, arterial routes, roundabouts, downtown grid systems, etc.) through the application of computer software to better help plan, design and operate transportation systems.

Applications:

- When mathematical or analytical treatment of a problem is found infeasible or inadequate due to its complex nature.
- When there is some doubt in the mathematical formulation or results.
- When there is a need of an animated view of flow of vehicles to study their behaviour.
- Cheaper than field/analytical modeling
- Powerful tool to compare alternate strategies and improvement plans
- Allows for controlled experimentation
- Assumptions can be minimized since they are transparent.

Steps in simulation:

- Define the problem and the model objectives
- Speed-flow relationship, queuing problem, bus route scheduling, accident occurrence, gap acceptance, prediction on fuel consumption and so on.
- Define the system to be studied - Roadway, Vehicle and Driver characteristics-
- Actual flow situations, real time data including roadway condition, driver behaviour and so on
- Development of logic
- Development of simulation programme - Model development
- Using any programming language

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- Model calibration
- Model verification
- Model validation
- Documentation

7. Explain the significance of traffic enforcement and traffic education in ensuring traffic safety.

3 E's such as Engineering, Enforcement and Education can be utilized to reduce accidents.

Safety measures related to engineering

Road designs:

- Sight distances, width, horizontal and vertical alignment, intersection design elements
- Pavement surface characteristics, skid resistance values
- Necessary bypasses may be constructed
- Grade separated intersections

Preventive maintenance of vehicle

- braking system, steering system, lighting system should be checked regularly
- Heavy penalty on defective vehicles
- Special checks on public carriers

Before and after study

- By comparing the condition and collision diagnosis "before and after" the introduction of preventive measures
- After necessary improvements in design and enforcing regulation

Road lighting

- Proper road lighting especially at the intersections, bridge sites and at places where there are restriction in traffic movement

Safety measures related to enforcement

Speed control:

- Checks on spot speed of all vehicles should be done at different locations and timings and legal actions on those who violate the speed limit should be taken

Training and supervision

- The transport authorities should be strict while issuing licence to drivers of public service vehicles and taxis.
- Driving licence of the driver may be renewed after specified period, only after conducting some tests to check whether the driver is fit

Medical check

The drivers should be tested for vision and reaction time at prescribed intervals of time

Safety Measures related to education

The various measures of education that may be useful to prevent accidents are enumerated below.

Education of road users:

- The passengers and pedestrians should be taught the rules of the road, Correct manner of crossing etc.
- Introducing necessary instruction in the schools for the children and
- Posters exhibiting the serious results due to carelessness of road users.

Safety drive: Documentaries and films for road users and drivers

- Training courses and workshops
- Imposing traffic safety weeks

8. Explain the requirements of a good pricing system

The following are the requirements

1. Charges should be closely related to the amount of use made of the roads.
2. It should be possible to vary the price for different roads, at different times of the day/week/year or for different classes of vehicles.
3. Prices should be stable and ascertainable by the road users before they commence a journey.
4. Method should be simple for road users to understand and police to enforce.
5. It should be accepted by the public as fair to all.
6. Payment in advance should be possible although credit facilities to certain cases if possible.
7. Equipment used should be highly reliable.
8. The system should be amenable to gradual introduction commencing with experimental phase.
9. It should be capable of being applied to the whole country.
10. It should be free from fraud and evasion, both deliberate and unintentional.

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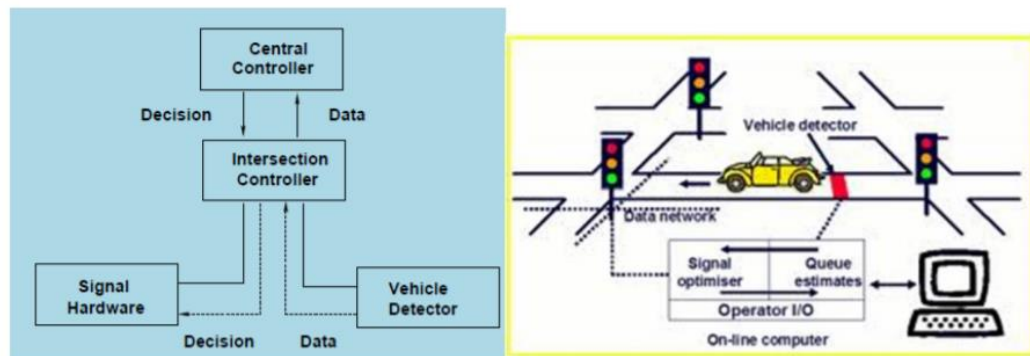
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10. Explain Area traffic control and it's components with neat sketches.

ATC systems are intelligent real-time dynamic traffic control systems which are designed to effectively respond to rapid variations in dynamic traffic conditions.

- It is a traffic responsive system that use data from vehicle detectors and optimize traffic signal time in real time.
- The timing plan of traffic controllers changed automatically.
- The technique employs digital computers for achieving the desired objective.

Advantages	Disadvantages
Minimizing journey time for vehicles	Very costly
Reducing accidents	Very complex
Increasing average saving in fuel	Suitable only for lane following traffic



Major units of ATC

- **Vehicle Detectors** - VD acts as a nodal point between vehicle and intersection controller. Detectors can be Ultrasonic, microwave radar, infrared laser radar, non-imaging passive infrared, video imaging, acoustic array, magnetic loop Inductive loop vehicle detector based.
- **Intersection Controller**- It collects the data from vehicle detector and sends it to the central control. Central control processes the data and sends it back to the intersection controller which then implements the signal timings as instructed at the intersection.
- **Communication Network**- The effectiveness of the entire system depends upon a communication network which involves transmission of signals in different forms.
- **Application Software** - Application software is a large and complex program involving multiple systems, various procedures for implementation.
- **Central (Regional) Control System**- It is the main unit of ATC. In this unit collected traffic data is processed to optimize various traffic parameters like-signal timing, phase change, delay Important and major task of ATC system is performed by this unit. It supervises all the units of ATC.

11. Write short notes on TSM

Transportation systems management (TSM) involves virtually all aspects of traffic engineering in a focus on optimizing system capacity and operations.

TSM action involves:

1. Traffic Management – this involves

- **Traffic Operations** - Intersection and roadway widening, One-way streets, Turn-lane installation, Turning-movement and land-use, New freeway lane using shoulders
 - **Traffic Control** - Local intersection signal improvement, Arterial signal system, Area signal system, Freeway diversion and advisory signing, Freeway surveillance and control
 - **Roadway Assignment**- Exclusive bus lane-arterial, restrictions, Take-a-lane, Add-a-lane, Bus-only street, Contraflow bus lane, Reversible lane systems, Freeway HOV bypass, Exclusive HOV lane-freeway, Take-a-lane, Add- a-lane
 - **Pedestrian and Bicycle** - Widen sidewalks, Pedestrian grade separation, Bikeways, Bike storage, Pedestrian control barriers
2. **Transit management-**
- **Transit Operations** - Bus route and schedule modifications, Express bus service, Bus traffic signal predemption, Bus terminals
 - **Simplified Fare Collection** - Marketing program, Maintenance improvements
 - **Transit Management** - Vehicle fleet improvements, Operations monitoring program
 - **Inter-Modal Coordination**- Park and ride facilities, Transfer improvements
3. **Demand management**
- **Paratransit**- Carpool matching programs, Vanpool programs, Taxi/group riding programs, Dial-a-ride
 - **Work schedule** - Elderly and handicapped service, Staggered work hours and flex-time, Four-day week
4. **Restrain measures**
- **Parking Management**- Curb parking restrictions, Residential parking control, Off-street parking, restrictions, HOV preferential parking, Parking-rate changes
 - **Restricted Areas** - Area licensing, auto-restricted zones, Pedestrian malls, Residential traffic control
 - **Commercial Vehicle** - On-street loading zones, Off-street loading zones, Peak-hour on-street loading prohibition, Truck route system
 - **Pricing** - Peak-hour tolls, Low-occupancy vehicle tolls, Gasoline tax, Peak-off-peak transit fares, Elderly and handicapped fares, Reduced transit fares

12. Write short note on congestion pricing

Road pricing is a method of road user taxation, charging the users of congested roads according to the time spent or distance travelled on those. Congestion pricing or congestion charges is a pricing strategy that is used to regulate demand, without increasing supply and thus making it possible to manage congestion.

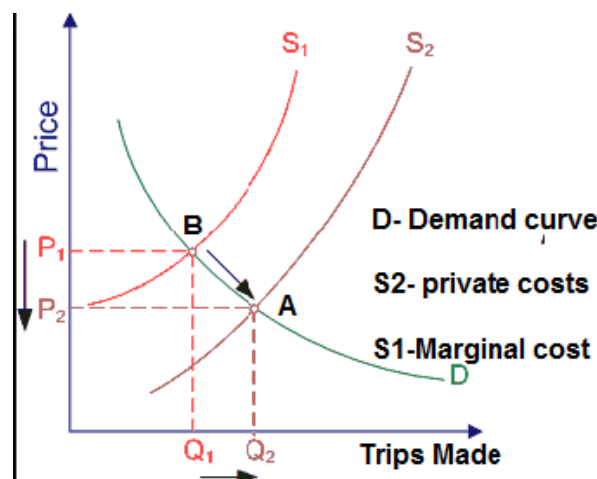
This mechanism to control demand includes higher peak charges for use of bus services, electricity, metros, railways, telephones, and road pricing to reduce traffic

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congestion; airlines and shipping companies may be charged higher fees for slots at airports and through canals at busy times. There are different mechanisms that can be used to decide upon congestion pricing. In the recent years to quantify the congestion in any road stretch, congestion index is used. The congestion index is calculated as $(1 - x/y)$, where x is the observed speed and y is the expected speed. It is concluded that 0.25 is the average congestion index on a scale of 0–0.6, where ‘0’ indicates good and ‘0.6’ indicates poor index value.

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.

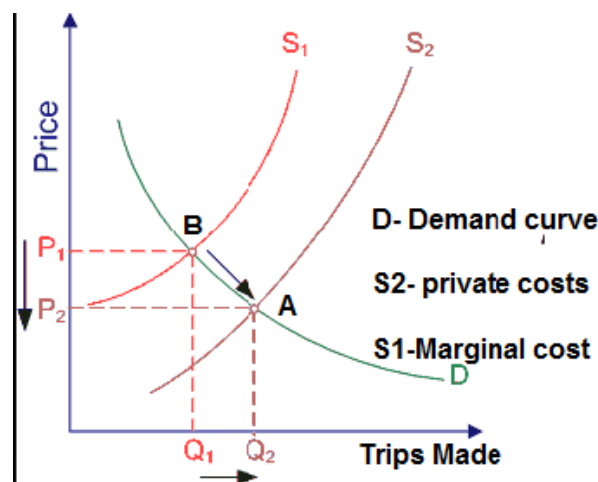


13. Write short note on parking pricing.

Parking pricing (also called user pay and metered parking) refers to direct charges for using a parking space. Efficient parking pricing can provide numerous benefits including increased turnover and therefore improved user convenience, parking facility cost savings, reduced traffic problems, and increased revenues. Parking pricing is the best practice that can be used for integrated parking management program. Charging users directly for parking tends to be more efficient and equitable and generate revenues that can finance new services or reduce rents and taxes. Potential benefits include

- Increased turnover of the most convenient places
- Reduces the number of spaces to meet the demand.
- Encourages long-term parkers to use alternate modes
- Reduces total traffic
- Generates revenue

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14. Suggest some traffic regulatory measures suitable for urban areas.

Traffic regulations include the regulations imposed on drivers and road users, vehicles.

Regulations on vehicles

1. Speed limits: this is generally controlled by the type and volume of traffic. This is also dependent upon
Environment of roads
Traffic composition
Character of road
Casualty

Category of roads	Light and medium vehicles, kmph	Heavy vehicles, kmph
Major roads of arterial roads	50	40
Roads with moderate traffic	40	30
Congested roads	30	20

2. Enforcement of speed limits – violators will be summoned or arrested or punished. For enforcement, radar speedometers are installed.
3. Establishment of speed zones
4. Vehicle registration for different states, different purposes are categories with reference to registration plate number. The order of age can also be identified with reference to the alphabets associated with the number plate.
5. Construction and equipment of vehicles: regulations in this category include brake and steering system, length of the truck trailer unit if any, wheel load, wheel load, emission, use of horns, periodical testing and inspection of vehicles, prohibition on use of horns and so on.
6. Control of transport vehicles – regulations with reference to goods movement, competition among different modes and so on.
7. Insurance: mainly to cover the liability in respect of death or injury to persons or damage to any property

Regulations concerning the driver

1. Licensing of the driver – given to an individual after he passes a test of competence. He should be able to portray his ability as a driver as well as his knowledge in different rules and regulations.
2. Requirements of physical fitness – night blindness, epilepsy, inadequate perception, heart diseases etc make a person unfit for driving
3. Age of drivers – in india, an individual should be of 18 years of age to get a driving license, whereas he should be of minimum of 20 years to get license to drive transport vehicles.
4. Disqualification and endorsement of licenses- habitual drinking, dangerous driving, offences and penalties make a person unfit for driving.

15. What are the traffic regulations on cycles?

The following are the rules

- (i) Cycling under the influence of alcohol or drug can be considered as an offence.
- (ii) If cycle tracks are provided, it should be compulsorily be utilized.
- (iii) Not more than two cycles should remain abreast except at separate cycle tracks.
- (iv) Cyclists shall not be allowed to be towed by another vehicle.
- (v) Cyclists shall not use foot-paths
- (vi) Cycles should be parked at designated places.
- (vii) Cycles should be provided with good brakes, night lamps and red reflectors at rear and bells or horns.
- (viii) Riding with more than one person in a cycle is considered as an offence.
- (ix) Cyclists should maintain the extreme left of the carriage way.

16. What are the traffic regulations on motor cycles and scooters?

- (i) Wearing helmets is mandatory.
- (ii) All motor cycles should be provided with rear view mirror.

- (iii) Rear wheels of the two wheelers should be a screen to prevent loose getting entangled to the spokes of the wheels.
- (iv) A driver with a learner's license should not carry a pillion rider
- (v) Not more than a rider and a pillion rider (rear rider) shall be carried on a motor cycle or a scooter.
- (vi) A foot rest should be provided for a pillion rider.
- (vii) The load projections on either side of the two wheeler is restricted to 0.5 m from the longitudinal direction. It is restricted to 1 m on the rear side and 0.6 m on the front side.

17. What are the traffic regulations for pedestrian traffic?

Regulations are

- (i) Pedestrians should follow the rules and regulations. Else it is considered as an offence.
- (ii) Pedestrians should use footpaths.
- (iii) Pedestrians should cross the streets only at cross-walks
- (iv) Where footways are not provided, pedestrians shall walk on the right hand side of the road facing traffic.

18. What are the traffic regulations for animal vehicles?

Regulations are

- (i) Animal drawn vehicles should be prohibited from carrying long pipes, rods, bamboos etc.
- (ii) Height, length and width of loads shall be restricted to safe limits, depending upon the size of the carriage way.
- (iii) The animal drawn traffic shall invariably keep extreme left of the carriage way having mixed traffic.

19. What are the traffic regulations for animal on streets?

Regulations are

- (i) Driving of camels and elephants on busy streets should be prohibited.
- (ii) Cattle in droves should be prohibited on busy streets at peak hours.
- (iii) Cattle in droves shall be accompanied with sufficient attendants to completely keep them under control.
- (iv) A horse rider should maintain the extreme left of the carriage way.
- (v) A horse rider should not use cycle tracks.