Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Traffic Engineering

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. In detail explain the road user characteristics. (08 Marks)
b. Derive an expression for flow and concentration using Green-shield theory. (08 Marks)

OR

2 a. Explain the details of vehicle characteristics affecting road design. (08 Marks)
b. Explain urban traffic problems and measure to meet the problems. (08 Marks)

Module-2

3 a. Briefly explain the various causes of accidents. (08 Marks)
b. Define the term spot speed. Explain the presentation of spot speed data. (08 Marks)

OR

4 a. Explain the preventive measures to reduce accidents. (08 Marks)
b. Explain the importance and methods of traffic forecasting. (08 Marks)

Module-3

5 a. Enumerate the design factors and advantages of rotary intersection. (10 Marks)
b. Write short notes on: i) Road markings ii) Channelized intersections. (06 Marks)

OR

6 a. What are the advantages and disadvantages of traffic signal? (08 Marks)
b. Explain traffic signal design as per IRC method. (08 Marks)

Module-4

7 a. Explain various design factors of highway lighting. (10 Marks)
b. Explain the various detrimental effect of traffic noise. (06 Marks)

OR

8 a. List and explain different types of lighting layouts. (08 Marks)
b. Explain the measure to control the traffic noise. (08 Marks)

Module-5

9 a. Discuss the details of traffic system management. (08 Marks)
b. List and explain the various phases of traffic regulation. (08 Marks)

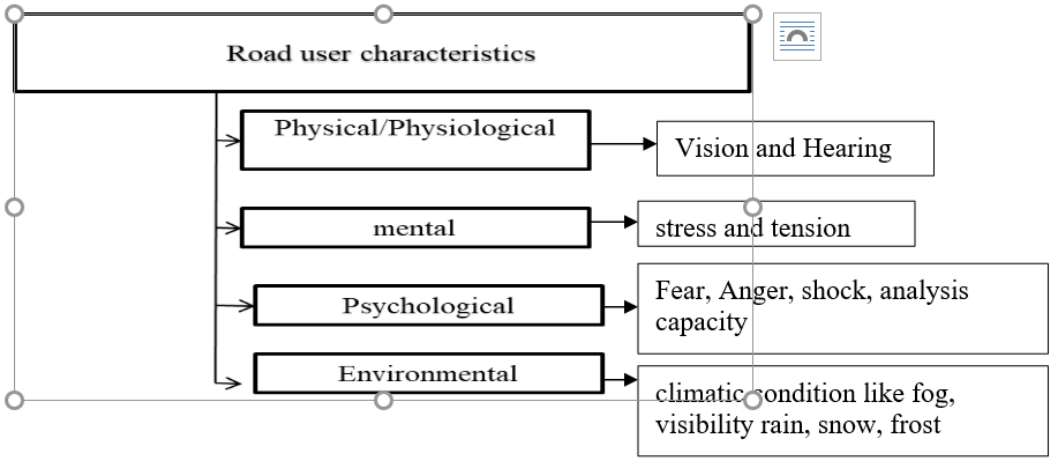
OR

10 Write short notes on: (16 Marks)
a. TDM b. ITS
c. Traffic congestion d. Road pricing system.

Module 1

1a) In detail explain various road user characteristics

8 marks



Vision:

Acute or clear vision cone-3" to 10" around the line of sight; legend can be read only within this narrow field of vision.

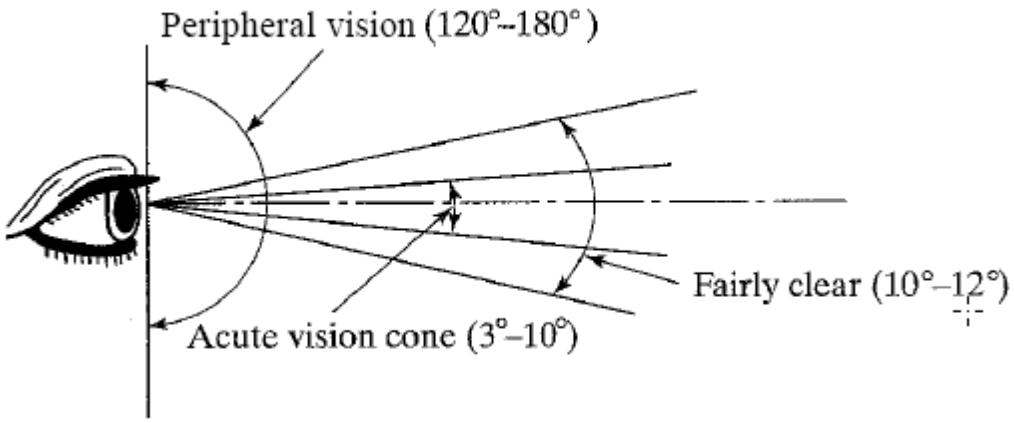
- Traffic signs are placed with in acute vision field
- Driver can see without changing his sight

Fairly clear vision cone-10" to 12" around the line of sight; color and shape can be identified in this field.

- Color and shapes can be identified

Peripheral vision-This field may extend up to 90" to the right and left of the centerline of the pupil, and up to 60" above and 70" below the line of sight.

- Stationary objects can not be detected but moving object can be
- Peripheral vision helps the driver for judgment of speed of moving vehicle



Hearing: Sound of nearing vehicles can alert the pedestrian. Elderly people with falling eye sight can better perceive through hearing.

PIEV theory:

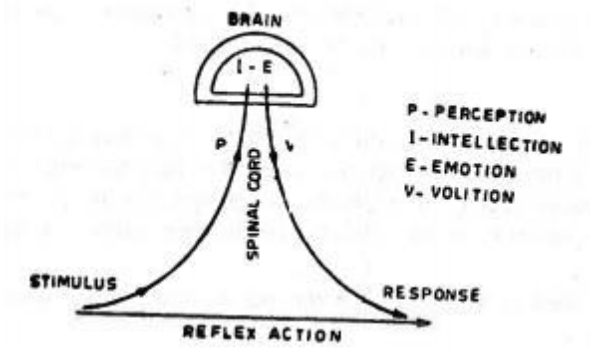
It splits the reaction time of driver into 4 components.

Perception: time required to perceive an object or situation. [Function of eyes, ears]

Intellection: time required for understanding the situation. [Function of brain]

Emotion: based on our emotions at the time [fear, anger etc] we reach the decision weather we want to stop or not. [function of brain]

Volition: once the decision of stopping has been finalised, time required for moving the foot from the gas to the brake peddle. [Obeying orders of brain; function of legs and hands.



1b. Derive an expression for flow and concentration using brief Green Shield theory.

8 marks

Greenshield assumed a linear speed-density relationship as illustrated in figure 1 to derive the model. The equation for this relationship is shown below.

$$v = v_f - \left[\frac{v_f}{k_j}\right].k \qquad 1$$

Where, v is the mean speed at density k, v_f is the free speed and k_j is the jam density. This above equation is often referred to as the Greenshields' model. It indicates that when density becomes zero, speed approaches free flow speed.

Substituting equation 1 in the equation 2

q = k x v 2

$$q = v_f.k - \left[\frac{v_f}{k_j}\right] k^2$$

This relationship is parabolic and can be given as provided in the following figure

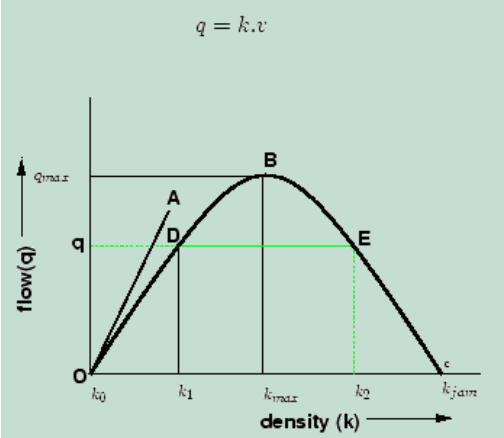


Figure 3: Relation between flow and density

From, the figure following points can be obtained

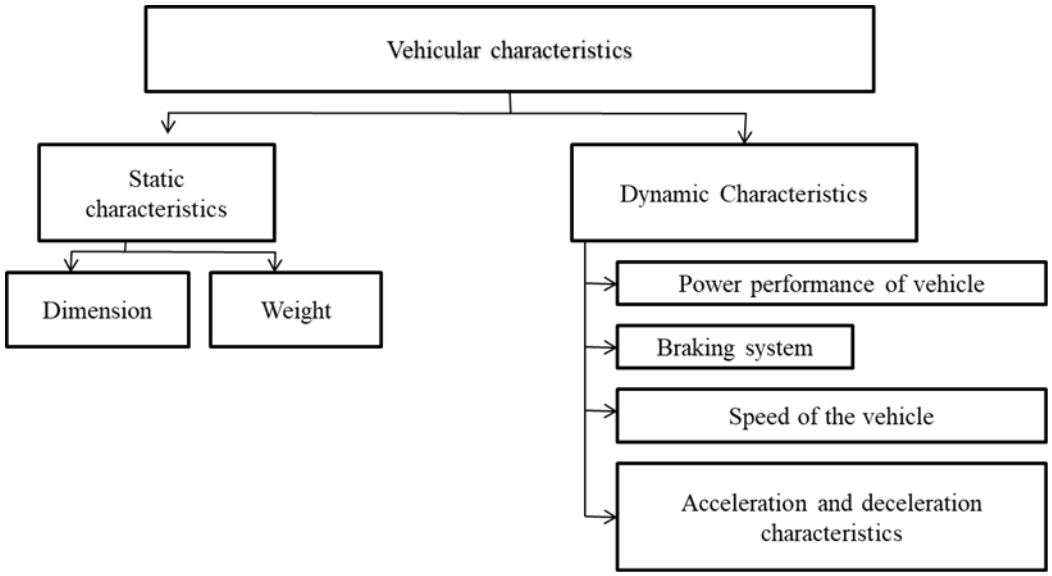
- When **density is zero**, **flow** will also be **zero**, since there is no vehicles on the road.
- When the number of vehicles gradually increases the density as well as flow increases.
- When more and more vehicles are added, it reaches a situation where vehicles can't move. This is referred to as the **jam density** or the maximum density.
- At jam density, flow will be zero because the vehicles are not moving.

- O refers to the case with zero density and zero flow.
- OA is the tangent drawn to the parabola at O, and the slope of the line OA gives the mean free flow speed.

2a) Explain in brief various vehicular characteristics affecting road design

8 marks

Solution)



Static characteristics influencing high way design include dimensions and weight. Their affects on high way design are provided in the following table

Dimensions	**Affects on road design**
Length of vehicle	Geometric design, capacity, overtaking distance and maneuver of vehicle, turning radius, parking facility, design of valley and dips
Width of vehicle	Width of traffic lanes, shoulders and parking, capacity, and traffic flow and traffic density.
Height of vehicle	Clearance of overhead structure, design of underpasses, height of barricades
Height of driver seat	Visibility distance

Height of headlight	Sight distance at valley curves
Weight	thickness of pavement, the vehicle weight is indirectly dependent upon the size of the vehicle and its turning radius

Dynamic characteristics are operational characteristics that involve the forces that cause the motion of vehicle. The different dynamic characteristics are

Power performance of vehicles

Braking system

Acceleration and deceleration characteristics

Speed of the vehicle

Power performance of vehicles: power developed by the engine should be sufficient to overcome all resistance to motion at the desired speed and to accelerate at any desired rate to the design speed. The various forces that are acting are

Rolling resistance

Air resistance

Grade resistance

Inertia force during acceleration and deceleration

Transmission losses

Braking system: when brakes are applied, friction between road surface and tyre comes into play and the vehicles come to a stop. This depends upon the roughness of the surface and whether it is dry/wet.

Acceleration and deceleration characteristics: maximum acceleration is achieved at low speeds. Cars have higher acceleration than commercial vehicles. Deceleration is caused when the engine is shut off and vehicle is allowed to coast and brakes are applied. This is dependent upon, the efficiency of brakes and coefficient of friction at the interface.

Speed of the vehicle: this will influence, acceleration and braking characteristics, braking sight distance and different sight distances.

2b) Explain urban traffic problems and measure to meet the problems

8 marks

Solution)

Urban Traffic Problems

1. Urbanization:

An urban area is an area with an increased density of human-created structures in comparison to the areas surrounding it. In Indian context urban area is one with the following characteristics:

• All places having 5000 or more inhabitants

• A density of not less than 400 per square kilometre

• At least three fourths of the adult male population employed in pursuits other than agriculture, are treated as urban areas'.

2. Motorization Booming economy, aspirations to own a car, unmatched public transport (with respect to demand, comfort or both), the government's encouraging policies (open car market, easy loan schemes), etc. are a few reasons for increasing motorization at a rapid rate.

Modal share

A major portion of vehicular composition during peak hour on important corridors in the metropolitan cities consists of cars, two wheelers and Intermediate Public Transport (IPT) (even though their mode share is less compared to PT), which clearly indicates the reason for extreme congestion on Indian urban roads during peak hours

3. Effects on mobility Mobility can be assessed in terms of speed, travel times, delays, etc. along the important corridors of the city. The average journey speed on important city corridors is in the range of 17–26 kmph. For the major cities, 0.25 is the average congestion Index index on a scale of 0–0.6, where '0' indicates good and '0.6' indicates poor index value. the congestion index is calculated as (1 – x/y), where x is the observed speed and y is the expected speed. The average volume to capacity (V/C) ratio on major corridors within cities (in 2007) has already reached values closer to or exceeding 1.

4. Effects on safety According to WHO, India topped in road accident fatalities, than any other country in the world.

5. Effects on environment Transport sector has a major share of 26% of total carbon emissions as compared to other sectors. Also, within the emissions from the transport sector, road transport has a major share of 65% as compared to rail, air and water transport. The major share of fuel consumption as well as emissions is by cars and two-wheelers as compared to buses. This scenario clearly results from the prevailing imbalance in modal split, which is not only affecting mobility, but also the environment.

Solutions:

Transport planning and modelling

One of the reasons for unregulated urban growth and sprawl in India is the lack of integration of land-use and transportation planning. Traditional demand modelling techniques which adopt trip-based approach and uses 'trips' as the basic unit of analysis have limitations of dealing with behavioural issues, for instance, modelling multistop tours, etc.

Top-down approach should be resorted to wherein we start with a set of goals/ objectives.

Non-motorized transport

In Indian cities, CBD's are the most congested/polluted parts and NMT unfriendly because the private vehicles are allowed to enter a CBD and it is perceived as good for businesses located inside a CBD. Study on impact of NMT and/or PT zones on the overall mobility within and outside a CBD, and on the businesses in general.

Improve pedestrian facilities.

Public transport

An affordable, networked public transport with a desired minimum level of service would always attract ridership in Indian cities

Good integration of multi-modal mass transit systems to serve the overall mobility needs of the city. Inter- and intra-connectivity that utilizes public and private mode and develop an efficient transport system.

Driver behaviour and road safety

Introducing an effective and comprehensive driver licensing and testing programme all over the country

Effective and comprehensive driver education courses.

Traffic management

Leving parking charges in CBDs and other busy areas.

Develop a clear parking policy which would guide the fixation of tariffs and other restraints on vehicular parking.

Congestion pricing is another good instrument to control travel demand.

Module 2

3a) Briefly explain various causes of accidents

8 marks

There are four basic elements in a traffic accident

(i) The road users

(ii) The vehicles

(iii) The road and its condition

(iv) Environmental factors

The different factors can be enlisted as follows:

(i) Drivers : excessive speed, carelssness, violation of rules and regulations, sleep, alcohol

(ii) Pedestrians: violation of rules, carelessness

(iii) Passengers : alighting or boarding the moving vehicles

(iv) Vehicle effects – failure of brakes, steering system, lighting system, tyre bursts any any other defect in the vehicles

(v) Road condition : slippery or skidding road surfaces, pot holes, ruts and other damaging conditions on the road surfaces

(vi) Road design: defect in geometric design like inadequate sight distance, inadequate width of shoulders, improper kerb design, improper lighting and improper traffc control devices.

(vii) Weather : unfavourale weather conditons like fog, mist, snow, dust, smoke or heavy rainfall and so on

(viii) Animals : stray animals on the road

(ix) Other causes : incorrect signs or signals, ribbon development, level crossing, advertisement boards and so on.

3b) Define the term spot speed. Explain the presentation of spot speed data

8 marks

Spot- speeds:

Spot speed is the instantaneous speed of a vehicle at a specified location.

Spot speed can be used to design the geometry of road like horizontal and vertical curves, super elevation etc

Presentation of spot speed:

Average speed of vehicle:

From the spot speed data, frequency distribution tables are prepared by arranging the data in groups covering various speed ranges and no of vehicles in each range. Arithmetic mean is taken as average speed

Cumulative speed of vehicle: Graphs plotted with average values of each speed group in x axis and cumulative percentage of vehicles travelled at or below different speeds on y axis

85th percentile speed: The speed **at or below which 85% vehicles** are passing a point on the highway or only 15% vehicles move above the 85th percentile speed. This is **upper speed limit.** This is adopted for Safe speed limit

98th percentile speed: 98% of vehicle move at or below this speed Highway. This is adopted for **geometric design**

15th percentile speed: 15% of vehicle move at or below this speed. This is the **minimum speed** on major highways.

At a safe zone speed is more than **15th percentile speed** and less than **85th percentile speed.**

Modal speed: The speed at which most of the vehicles prefer to move. The **most preferred speed on a road** is modal speed It can be determined by **normal distribution curve**.

Following figures shows the graphical representation of spot speed.

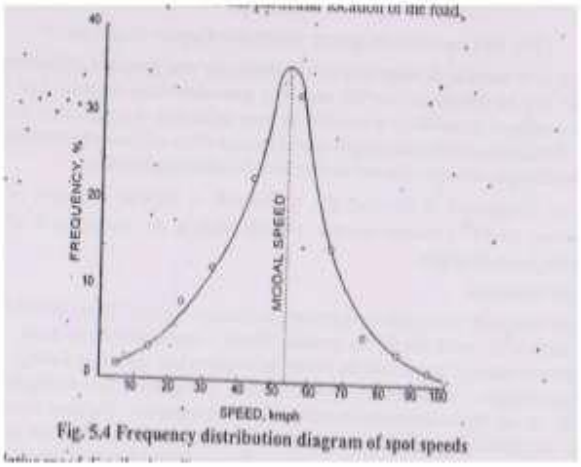
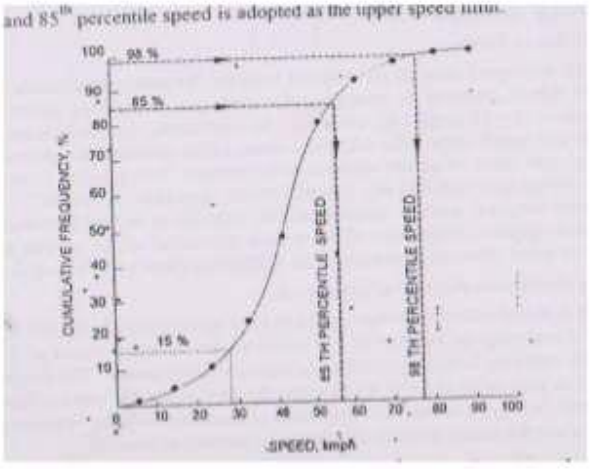


Fig. 5.4 Frequency distribution diagram of spot speeds



4a) Explain preventive measures to reduce accidents

8 marks

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

4b) Explain importance and methods of traffic forecasting

8 marks

Importance of traffic forecasting: Scarcity of capital, to meet the traffic demand

Factors influencing traffic forecast

- Population Growth/Migration
- Land Use Changes
- National/Regional Economy
- Vehicle Operating Costs
- Capacity Restraints
- Induced Traffic due to new road facilities nearby
- Vehicle ownership levels
- Availability of alternative transport modes

Methods of traffic forecast include collection of data and model predictions.

Data for traffic prediction

Time series data consist of data that are collected, recorded, or observed over successive increments of time.

Cross-sectional data are observations collected at a single point in time.

Panel data are cross-sectional measurements that are repeated over time, such as yearly passengers carried for a sample of airlines.

Traffic forecast - Models

Linear trend

$$Y_t = \beta_0 + \beta_1 t + \varepsilon$$

Exponential Trend

$$Y=a(1+b)^T \quad or \quad \ln(Y) = \ln(a) + T \times \ln(1+b)$$

Polynomial Trend Analysis

$Y= a + bT + cT^2$

Forecasts based on Past Trends and Extrapolation – this can be done based on experience.

Module 3

5a) Explain the design factors and advantages of traffic signal

8 marks

Advantages of traffic signals

- Provide orderly movement of traffic at the intersection.
- The quality of traffic flow is improved by forming compact platoons of vehicles, provided all the vehicles move at approximately the same speed.
- Reduction in accidents due to crossing conflict, notably the right angled collisions.
- Traffic handling capacity is highest among the different types of intersections at-grade.
- Provide a chance to traffic of minor road to cross the continuous traffic flow of the main road at reasonable intervals of time.
- Pedestrians can cross the roads safely at the signalized intersection.

Design principles of traffic signal include design of following phases

1. Cycle length design
2. Green splitting
3. Phase design,

Following terms are necessary while designing traffic signal

Cycle: A signal cycle is one complete rotation through all of the indications provided.

Cycle length: Cycle length is the time in seconds that it takes a signal to complete one full cycle of indications.

It indicates the time interval between the starting of green for one approach till the next time the green starts. It is denoted by C.

Interval: It indicates the change from one stage to another. There are two types of intervals - change interval and clearance interval.

- Change interval is also called the yellow time indicates the interval between the green and red signal indications for an approach.
- Clearance interval is also called all red and is provided after each yellow interval indicating a period during which all signal faces show red and is used for clearing off the vehicles in the intersection.

Green interval: It is the green indication for a particular movement or set of movements and is denoted by Gi .

Red interval: It is the red indication for a particular movement or set of movements and is denoted by Ri .

Phase: The part of the signal cycle time that is allotted to stop or movement of vehicles is called as signal phase. The duration of "stop" phase is red phase, duration of "go" phase is green phase

Lost time: It indicates the time during which the intersection is not effectively utilized for any movement. For example, when the signal for an approach turns from red to green, the driver of the vehicle which is in the front of the queue, will take some time to perceive the signal (usually called as reaction time) and some time will be lost before vehicle actually moves and gains speed.

There are 4 different methods for signal design

1. Trail cycle method
2. Approximation method based on pedestrian crossing requirement
3. Webster's method
4. Design as per IRC guidelines

5b) Write short note on road marking and channelized intersection

8 marks

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.

The road markings are classified as

- Longitudinal markings
- Transverse markings
- Object markings
- Word messages

Longitudinal markings

- Broken lines are permissive in character and allows crossing with discretion, if traffic situation permits.
- Solid lines are restrictive in character and does not allow crossing except for entry or exit from a side road or premises or to avoid a stationary obstruction.
- Double solid lines indicate severity in restrictions and should not be crossed except in case of emergency.

They are of the following types

- Centre-line marking
- Traffic lane lines
- No passing zones
- Warning lines
- Edge lines

Centre line:

- Centre line separates the opposing streams of traffic and facilitates their movements.
- Usually no centre line is provided for roads having width less than 5 m and for roads having more than four lanes.

Traffic lane lines

- The subdivision of wide carriageways into separate lanes on either side of the carriage way helps the driver to go straight and also curbs the meandering tendency of the driver.

No passing zones

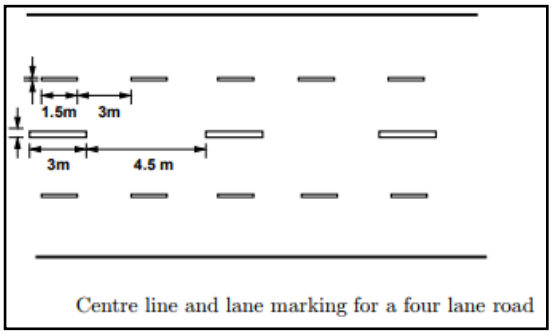
- No passing zones are established on summit curves, horizontal curves, and on two lane and three lane where overtaking maneuvers are prohibited because of low sight distance.
- It may be marked by a solid yellow line along the centre or a double yellow line.

Warning lines

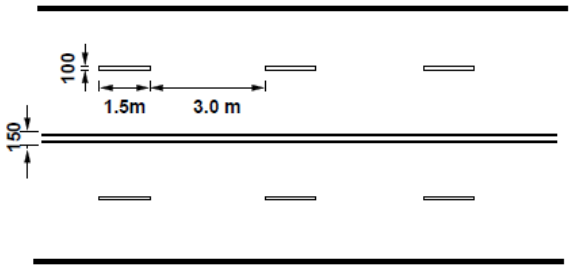
- Warning lines warn the drivers about the obstruction approaches.
- They are marked on horizontal and vertical curves where the visibility is greater than prohibitory criteria specified for no overtaking zones.
- They are broken lines with 6 m length and 3 m gap.

Edge lines

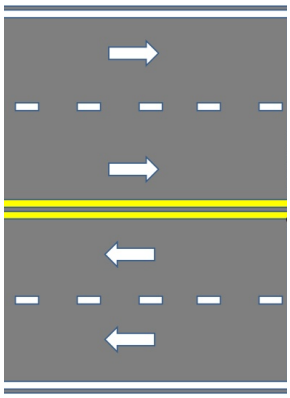
- Edge lines indicate edges of rural roads which have no kerbs to delineate the limits upto which the driver can safely venture.
- They should be at least 150 mm from the actual edge of the pavement.
- They are painted in yellow or white.

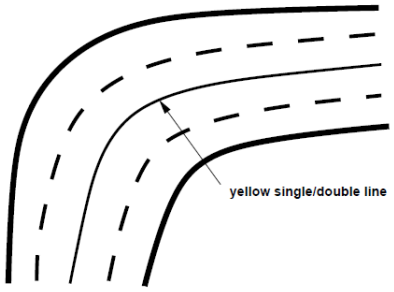


Centre line and lane marking for a four lane road

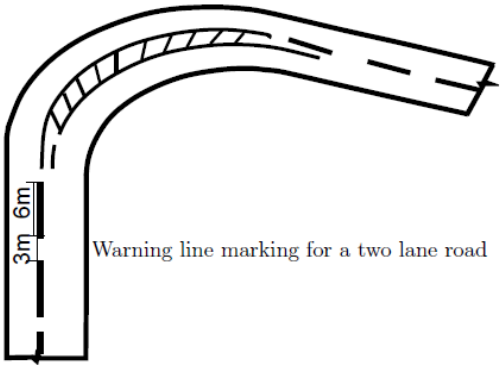


Lane marking for a four lane road with solid barrier line

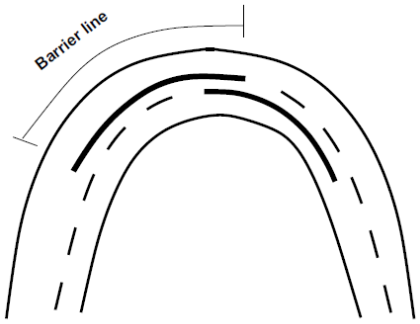




Barrier line marking for a four lane road



Warning line marking for a two lane road



No passing zone marking at horizontal curves

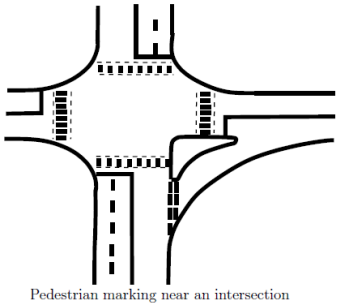
Transverse markings

Stop line:

- Stop line indicates the position beyond which the vehicles should not proceed when required to stop by control devices like signals or by traffic police.
- They should be placed either parallel to the intersecting roadway or at right angles to the direction of approaching vehicles.

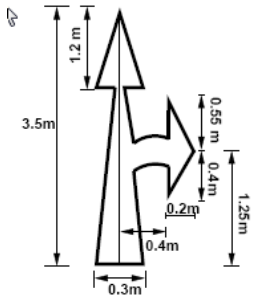
Pedestrian crossings

- Pedestrian crossings are provided at places where the conflict between vehicular and pedestrian traffic is severe.
- At intersections, the pedestrian crossings should be preceded by a stop line at a distance of 2 to 3m for unsignalized intersections and at a distance of one meter for signalized intersections.


Pedestrian marking near an intersection

Directional arrows

- Directional arrows should be used to guide the drivers in advance over the correct lane to be taken while approaching busy intersections.
- Because of the low angle at which the markings are viewed by the drivers, the arrows should be elongated in the direction of traffic for adequate visibility.



Object markings

Objects within the carriage way:

The obstructions within the carriageway such as traffic islands, raised medians, etc. may be marked by not less than five alternate black and yellow stripes.

The stripes should slope forward at an angle of 45◦ with respect to the direction of traffic..

Objects adjacent to carriageway

Objects adjacent to the carriageway like subway piers and abutments, culvert head walls etc. should be marked with alternate black and white stripes at a forward angle of 45◦ with respect to the direction of traffic.

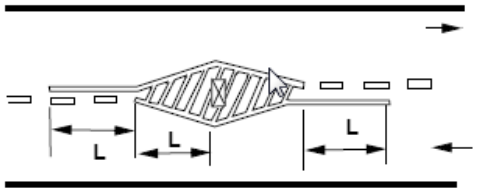
Word messages

Parking:

- The marking of the parking space limits on urban roads promotes more efficient use of the parking spaces and tends to prevent encroachment on places like bus stops, fire hydrant zones etc. where parking is undesirable.
- Such parking space limitations should be indicated with markings that are solid white lines 100 mm wide.

Hazardous location

- Wherever there is a change in the width of the road, or any hazardous location in the road, the driver should be warned about this situation with the help of suitable road markings.



Channelized intersection:

Channelized intersections- Vehicles approaching an intersection are directed to definite paths by islands, marking etc. and this method of control is called channelization.

Advantages:

Provides more safety and efficiency.

Reduces the number of possible conflicts

Reduces the area of conflicts available in the carriageway.

The presence of traffic islands, markings etc. forces the driver to reduce the speed and becomes more cautious while manoeuvring the intersection.

A channelizing island also serves as a refuge for pedestrians and makes pedestrian crossing safer**.**

This can be at grade and grade separated intersections. Rotary intersection is an example of channelized intersection

At grade intersection:

- An intersection is the area shared by the joining or crossing of two or more roads at same level is at grade intersection.

Grade separated Intersections

- Grade-separated intersections are provided to separate the traffic in the vertical grade.
- Different types of grade-separators are flyovers and interchange.

  Flyovers itself are subdivided into overpass and underpass.

6a) What are the advantages and disadvantages of traffic signal

8 marks

Advantages of traffic signals

- Provide orderly movement of traffic at the intersection.
- The quality of traffic flow is improved by forming compact platoons of vehicles, provided all the vehicles move at approximately the same speed.
- Reduction in accidents due to crossing conflict, notably the right angled collisions.
- Traffic handling capacity is highest among the different types of intersections at-grade.
- Provide a chance to traffic of minor road to cross the continuous traffic flow of the main road at reasonable intervals of time.
- Pedestrians can cross the roads safely at the signalized intersection.
- When the signal system is properly co-ordinate, there is a reasonable speed along the major road traffic.
- Automatic traffic signal may work out to be more economical when compared to manual control.

Disadvantages of traffic signals

- The rear-end collisions may increase.
- Improper design and location of signals may lead to violations of the control system.
- Failure of the signal due to electric power failure or any other defect may cause confusion to the road users.
- The variation in vehicle arrivals on the approach roads may cause increase in waiting time on one of the roads and unused green signal time on other road, when fixed time traffic signals are used.
- Excessive delay of vehicle may be caused particularly during off-peak hours. • Drivers may be induced to use less adequate and less safe routes to avoid delays at signals.

6b) Explain traffic signal design using IRC method

8 marks

i. The pedestrian green time required for the major and minor roads are calculated based on walking speed of 1.2 m/s and initial walk time of 7 s. these are the minimum green time required for the vehicular traffic on the minor and major roads respectively.

ii. The green time required for vehicular traffic on the major road is increased in proportion to the traffic of the approach roads.

iii. The cycle time is calculated after allowing an amber time of 2 seconds

iv. The minimum green time required for clearing vehicles arriving during a cycle is determined for each lane of the approach road assuming that the first vehicle will take 6 s and the subsequent vehicles of the queue will be cleared at a rate of 2 s. The minimum green time required for the vehicular traffic on any of the approaches is limited to 16 s.

v. The optimum cycle time is calculated as per Webster's method and the saturation flow is assumed as 525 w, if the approach width is more than 5.5 m. For approach widths less than 5.5 m the saturation flow may be assumed between 1850 PCU/hr to 2990 PCU/hr. the lost time is calaculted from the amber time and the initial delay of 4 s for the first vehicle on each leg.

vi. The signal time and the phases may be revised keeping in view the green time required for clearing the vehicles and the optimum cycle length determined in the above steps.

Optimum cycle time as per Webster's method

C_0 is always restricted to 120 sec

$$C_0 = \frac{1.5\,L + 5}{1 - Y_i}$$

Calculate green time for the phases;

Co-L : Effective green time

$$G_1 = \frac{y_1}{Y}(C_o - L), \text{and } G_2 = \frac{y_2}{Y}(C_o - L)$$

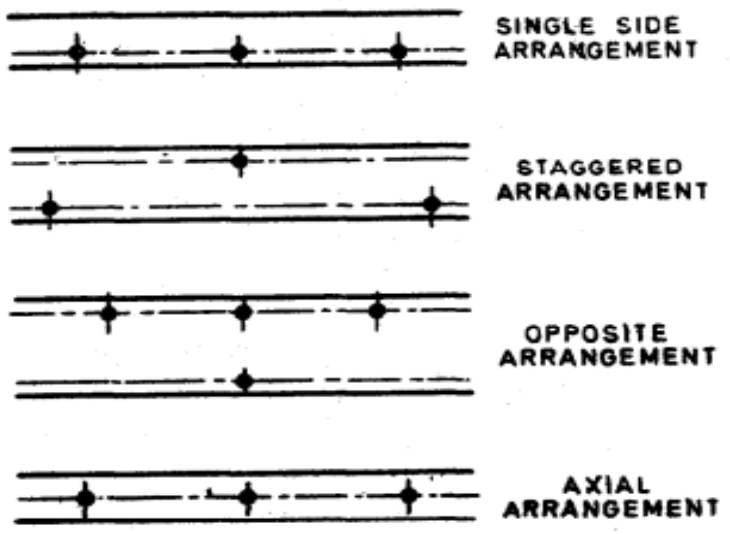
Module 4

7a) Explain design factors for highway lighting

8 marks

Design factors for highway lighting are

- Lamps – the various types of lamps in use for highway lighting are filament, fluorescent lamps, sodium or mercury vapour lamps.
- Luminaire distribution of light- the distribution of light should be downward so that high percentage of lamp light is utilized for illuminating the pavement and the adjacent areas. The distribution of luminaire should cover the pavement between the kerbs and provide adequate lighting the adjacent areas i.e., 3 m to 5 m beyond the pavement edges. According to Indian Standards Institution, an average level of illumination of 30 lux on important roads carrying fast traffic and 15 lux on main roads, the ratio of minimum to average illumination being 0.4
- Spacing of lighting units – large lamps with high mountings and wide spacings would be preferred from economy point of view.
- Height and overhang of mounting – usually mounting height range from 6 m to 10 m.
- Lateral placement – the street lights should not be too close to the pavement edge. For roads with raised kerbs, the pole should be at a distance of 0.3 m to 0.6 m from the edge of the kerb.
- Lighting layouts – this can be either single sided, staggered or central.



Spacing (s) of street lamp can be computed as

- $s = \frac{\text{Lamp lumen} \times \text{coeffecient of utilization} \times \text{Maintenance factor}}{\text{average flux} \times \text{width of the road}}$

7b) Explain detrimental effect of traffic noise

8 marks

Solution)

Noise is the unwanted sound. Noise in cities is the result of a number of activities such as road traffic, aircraft, railways and industrial and constructional works.

Effect of noise: This can be classified into three

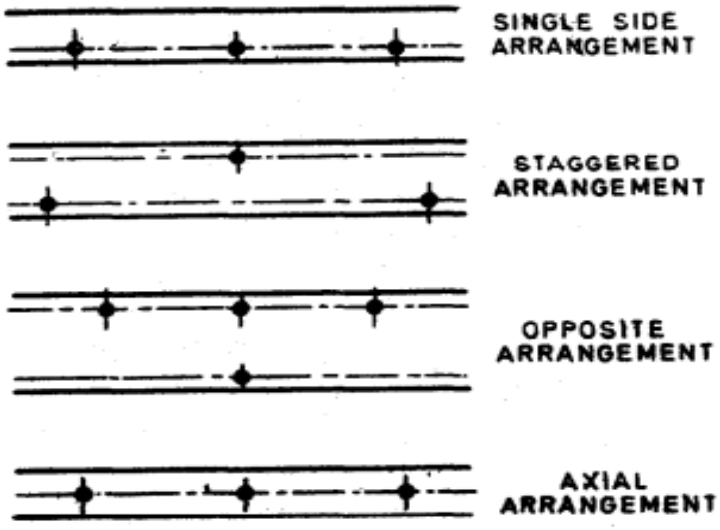
(i) Subjective effects: this include disturbance, noisiness etc and is difficult to be measured.

(ii) Behavioural effects: the noise can influence the behavior of people like sleeplessness, disturbance in studies, distraction in student's mind etc.

(iii) Physiological effects: it can cause startle or fright phenomenon. Considerable exposure can even cause deafness

8a) List and explain different types of lighting layout

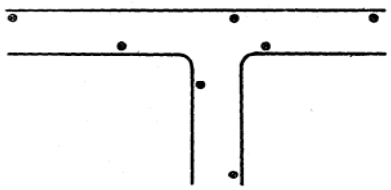
8 marks



- Single side arrangement is suitable for narrow roads.
- For wide roads, staggered, opposite or central lighting system can be provided.
- Spacing is decided based on location, lamp size, mounting height and lighting requirements. Spacing range between 30-60 m.
- At curves they are installed at closer spacing's than on straights.

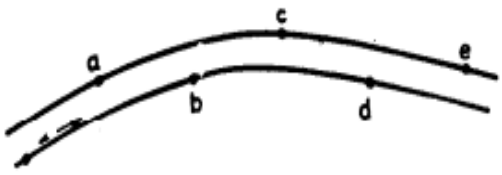
Basic arrangements of street lighting

5A Single Side Arrangement of Luminaires on a Bend

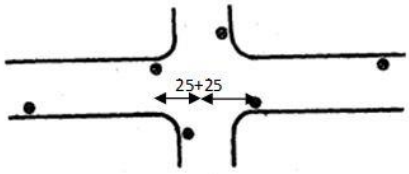


SITING RECOMMENDED AT A T-JUNCTION

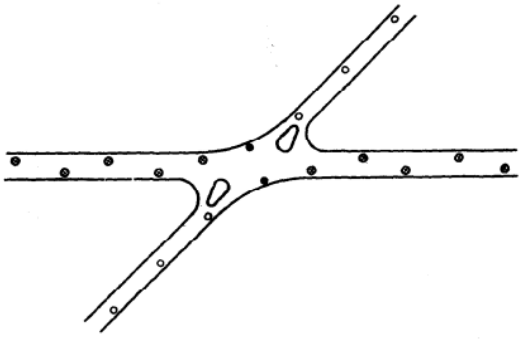
Prepare
Departr



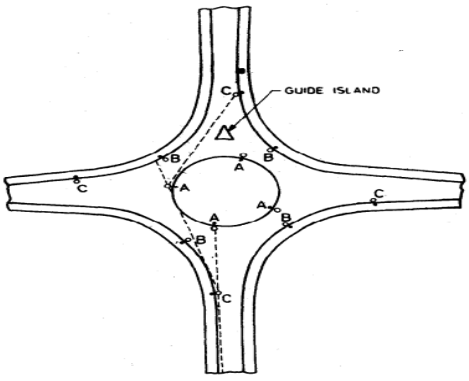
6A Staggered Arrangement on a Curve



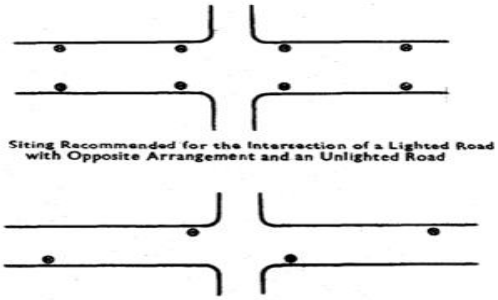
SITING RECOMMENDED AT THE INTERSECTION OF TWO ROADS LIGHTED WITH STAGGERED ARRANGEMENT



SITING RECOMMENDED AT ROAD WITH GUARD ISLAND



TYPICAL LAYOUT AT A ROUNDABOUT



SITING RECOMMENDED AT THE INTERSECTION

8b) Explain the measures to control traffic noise

8 marks

(i) Improve vehicle design and maintenance.

(ii) Use of small cars instead of big ones.

(iii) Patronage of public transport system.

(iv) Use of alternative fuels and method of propulsion.

(v) Restraining traffic through road pricing.

(vi) Stopping engines at the time of delays at intersections

(vii) Constructing bypasses and ring roads.

(viii) Staggering work hours

Module 5

9a) Discuss the details of traffic system management

8 marks

Traffic 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-dav 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, Peaoff-peak transit fares, Elderly and handicapped fares, Reduced transit fares

9 b) Describe and explain various phases of traffic regulation

8 marks

The phases of traffic regulations include The first phase of traffic regulation is

a) Driver controls

b) Vehicle controls

c) Traffic flow regulations

d) General controls

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

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 loaf, 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.

Some other general regulations and provisions are made.

They include reporting of accidents, recording and disposing traffic violation cases, etc

10) Write short notes on a) TDM b) ITS c) Traffic congestion d) Road pricing system

16 marks

a) 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.

b) ITS

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 maintainence, 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

c) Traffic Congestion

Traffic Congestion is directly proportional to Traffic density which in turn is related to traffic flow and speed. The different factors that contribute to traffic congestion are

1. Dimensions of the road – this will influenc the capacity of the road
2. Dimensions of the vehicle – dependeing upon the size of the vehicle, wheel load and its axle configurations along with its power characteristics will change. This will influence congestion
3. Speed of the vehicle – higher the speed, less will be the congestion
4. Type of road – NH, SH, MDR, VR and so on
5. Road geometry – gradient, sight distance and so on. If the sight distance is less, congestion will be more
6. Travel demand – this is dependent upon the location. If the location is a city centre, then more will be the congestion and vice versa.

Problems associated with traffic congestion are

1. Time delays
2. Deficiency in parking facilities
3. Increase in private vehicles

Solution towards traffic congestion

1. Promote Non-motorized and public transport
2. Congestion pricing
3. Promotion of mass transit like metros
4. Promote peripheral parking system

d) Road pricing system

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.