1. **Discuss various urban traffic problems that India is facing. List some remedial measure also.**

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.

PART B

2a) A vehicle of weight 1800 Newton has to accelerate at 3 m/s2 from a speed of 10Kmph to 15Kmph in the first gear. The gradient has +1.2% and coefficient of rolling resistance is 0.025. The frontal area and coefficient of air resistance are 2.38 m^2 and 0.39 kg/m^2 respectively. The transmission and rear axle gear ratios are 2.85:1 and 3.87:1 respectively. The radius and deformation factor of the tyres are 0.35 m and 0.945 respectively. Determine the engine horse power required and the speed of the engine if transmission efficiency is 0.9.

Solution)

Weight = 1800 N; mg = 1800; m = 183.48 kg

Average speed = 12.5 kmph = 12.5 *5/18= 3.47 mps

Tractive force Pp = Pf + Pa ± Pi ± Pj

Pf = mgf = 183.48*9.81*.025 = 44.99 N

Pa = Ca*A v^2 = 0.39 *2.38 * $(3.47)^2$ = 11.176 N

Pi = mgi = 183.48*9.81*1.2/100 =21.599 N

Pj = m a = 183.48 * 3 = 550.44 N

Pp = 44.99+11.176+21.599+550.44 = 628.205N

Power output, watt = Pp X v = 628.205*3.47=2179.87 W

Power output, hp = 2179.87/735 = 2.96 hp

Engine power, hp = Power output/ transmission efficiency

= 2.96 /0.9 = 3.29 hp

$$v = \frac{2\,\pi r_w n}{60\,G_t G_a}$$

Where,

Gt: transmission gear ratio

Ga: rear axle gear ratio
n : engine speed in RPM
r_w: λr_0
λ : tyre deformation factor

n = 1105.54 rpm

2b) List the different methods for conducting traffic volume studies. Explain Registration number plate method and enumerate its advantages and limitations

Solution)

- Manual method
- Combination of manual and mechanical
  - Multiple pen recorder
- Automatic/mechanical counter methods
  - Pneumatic tube
  - Electric contact devices
  - Coaxial cable
  - Photoelectric devices
  - Radar
- Moving Observed method
- Photographic/video graphic method

Registration number plate method

Used for measurements of running and journey speed:

- ✓ Observers are stationed at the ends of measuring section say 0.5 km -1 km
- ✓ Time and registration no of the vehicle are recorded as and when they enter and leave the section
- ✓ By matching registration nos later, journey time and speed can be determined

Advantages:

No sophisticated instruments are required
Easy

Disadvantages:

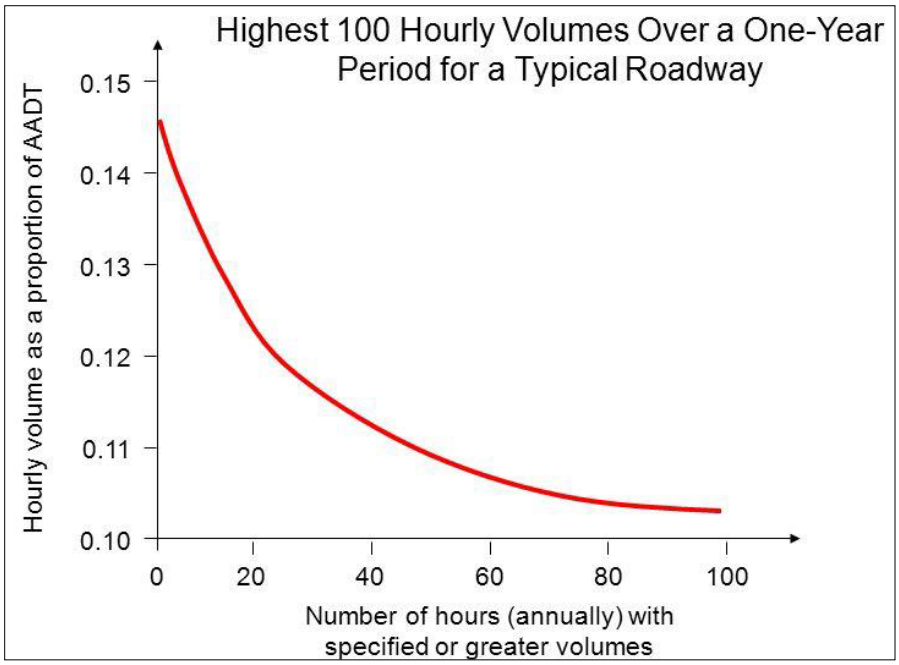
1) Laborious, time consuming
2) Cannot be used for urban roads with many intersections , Hence convenient only for rural roads
3) Only journey speed can be determined not running speed

2c) Write a short note on 30th highest hourly volume and explain its significance

Solution)

Thirtieth highest hourly volume is the hourly volume that will be reached only thirty times in a year or exceeded only 29 times in a year and all other hourly volumes of this year will be less than this value.

Significance: the highway facility design with respect to 30th highest hourly volume is found to be satisfactory with respect to consideration of facility as well as cost. This is because cost is less when compared to peak hourly volume and there will be congestion only 29 hours in a year which is a reasonable measure.



3a. Spot speeds studies were carried out at a city road during certain period of time and the data are tabulated as follows. Suggest (i) Higher speed limit for regulation (ii) Speed to check geometric design (iii) Lower speed group causing congestion (iv) Medium speed (v) Modal speed

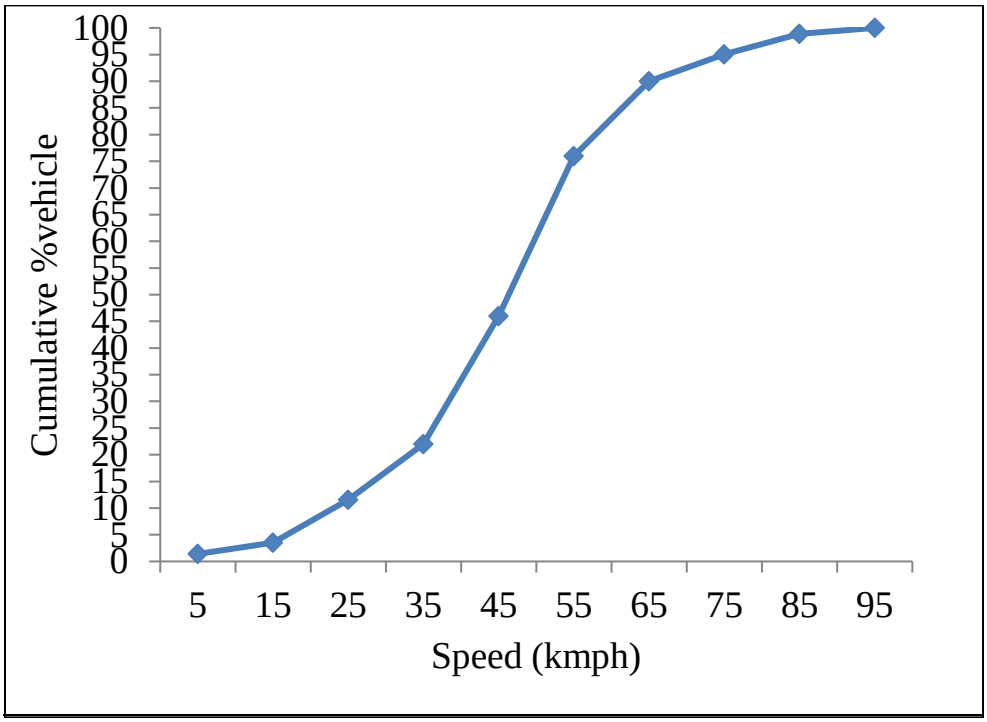
Speed Group (kmph)	**0-10**	**11-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**	**80-90**	**90-100**
No. of vehicles	**12**	**18**	**68**	**89**	**204**	**255**	**119**	**43**	**33**	**9**

Solution)

Speed range (kmph)	**Average Speed (kmph)**	**No of vehicles**	**% vehicle (no of vehicles/total vehicles)**	**Cumulative % vehicles**
0-10	5	12	1.41%	1.41%
10-20	15	18	2.12%	3.53%
20-30	25	68	8.00%	11.53%
30-40	35	89	10.47%	22%
40-50	45	204	24.00%	46%
50-60	55	255	30.00%	76%
60-70	65	119	14.00%	90%
70-80	75	43	5.06%	95.06%
80-90	85	33	3.88%	98.88%

90-100	95	9	1.06%	100%

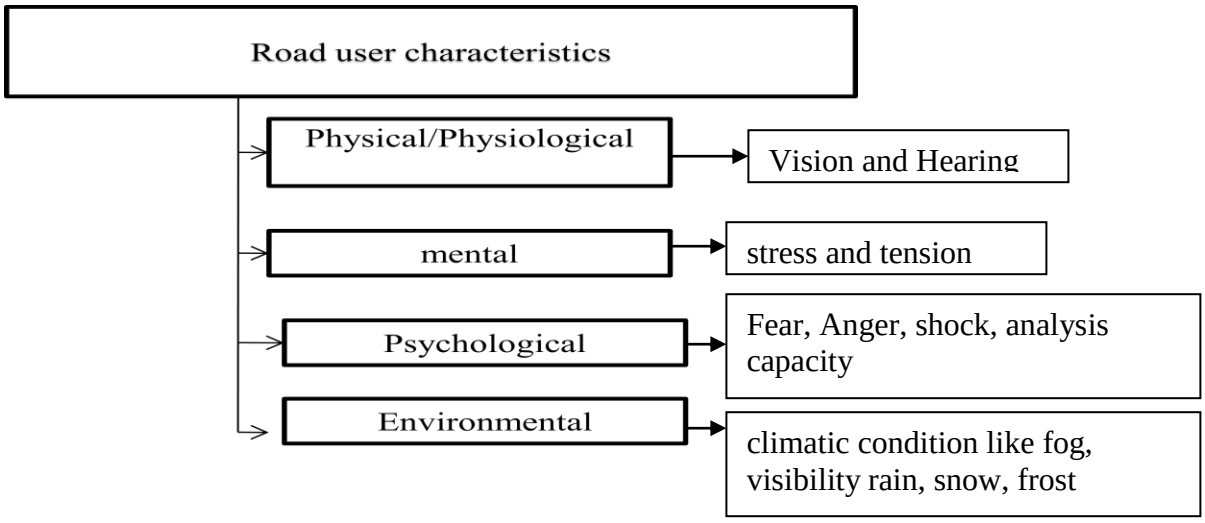
Total vehicles= 12+18+68+89+204+255+119+43+33+9=850
Draw the graph between speed (kmph) in x axis and cumulative % vehicles in y axis then



Design speed for checking geometric design : 98th percentile speed = 82.57 kmph
Lower bound speed = 15th percentile speed = 38.31 kmph
Upper bound speed = 85th percentile speed= 61.42 kmph
Medium speed = 50th percentile speed = 46.33 kmph
Modal speed = most preferred speed = 55 kmph

3(b) Explain road user characteristics. Describe PIEV theory and its importance in highway design.

Solution)Road user characteristics are divided into 4 types as provided below



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.

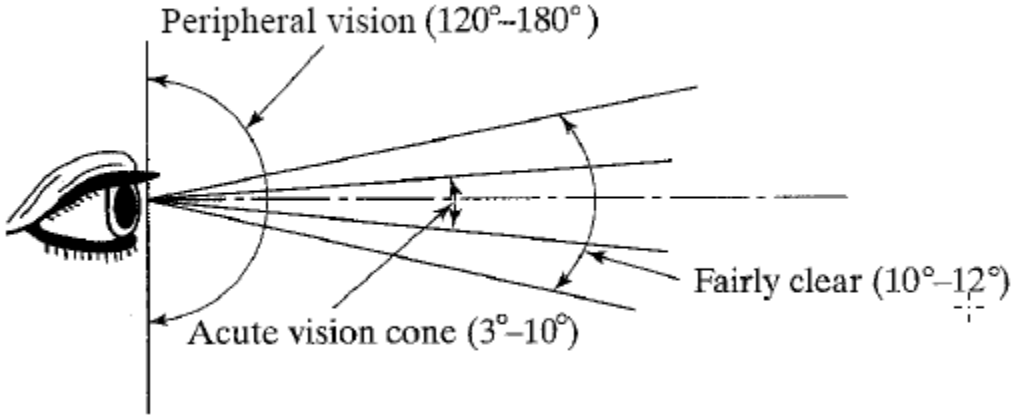
- Traffic signs are placed with in acute vision field
- Driver can see without changing his sight

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



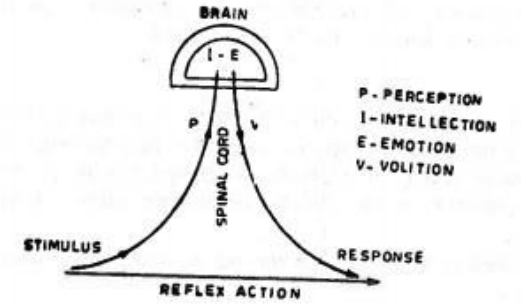
Hearing: Sound of nearing vehicles can alert the pedestrian. Elderly people with falling eye sight can better perceive through hearing.

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]



The PIEV time which is the summation of perception, intellection, emotion and volition time is known as total reaction time of the driver. The reaction time is considered as 2.5 seconds in urban and 3 seconds in hilly area for designing stopping sight distance (geometric design element) of roads.

(3c) With neat sketch explain enoscope method of measuring spot speed study. Discuss its advantages and disadvantages.

Enoscope/mirror box method:

- This is a long base method

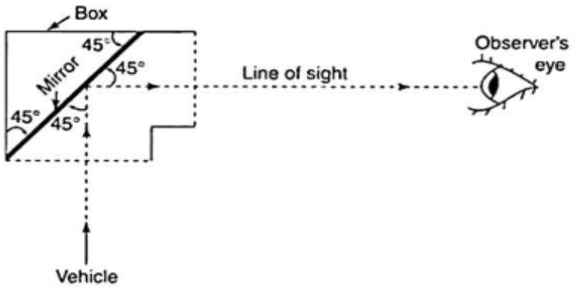


FIG. 4.8 *Principle of Enoscope*

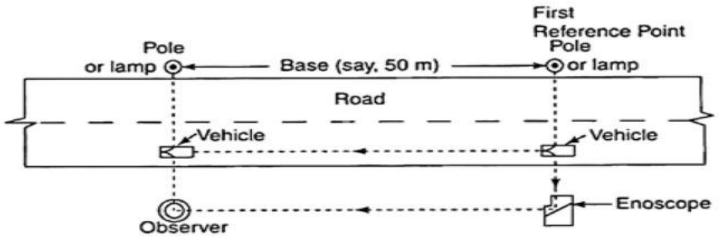


FIG. 4.9 *Spot speed using one Enoscope*

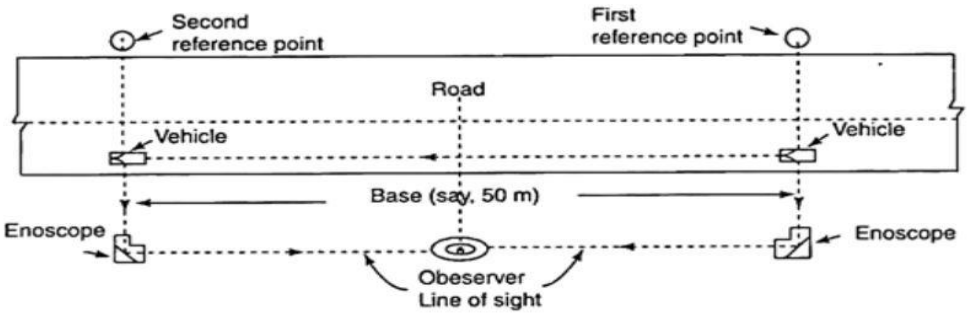


FIG. 4.10 *Spot speed using two enoscopes*

- The instrument is placed directly opposite to the first reference point and the observer stations himself at the second reference point.
- Stop watch is started as soon as the vehicle passes the first point and is stopped as soon as it passes the observer.
- If two enoscope is used, the observer stations himself midway between two reference points.
- Advantages:
  - Eliminates parallax error.
  - Equipment is of low cost, simple and can set up easily
- Disadvantages:
  - Time consuming and under heavy traffic condition it may be difficult to conduct the experiment

4a) What are the uses of speed and delay studies?

The length of a road stretch used for conducting the moving observer test is 0.5 km and the speed with which the test vehicle moved is 20 km/hr in both directions while moving along and against the flow. Given that the number of vehicles encountered in the stream while the test vehicle was moving against the traffic stream is 107, number of vehicles that had overtaken the test vehicle is 10, and the number of vehicles overtaken by the test vehicle is 74, find the flow and average speed of the stream.

Solution)

Uses of speed and delay study:

- Helps in deciding design speed and other geometric elements of the road such as curves, horizontal and vertical alignment

- For regulation and control of traffic operations
  e.g. signal design and locations of sign board
- For analysing the causes of accidents
- Identify relation between speed and accident
- Before and after road improvement schemes
- Determining congestion problems and capacity of roads
- Necessary for economical analysis
- To evaluate congestion, capacity and level of service
- Essential for trip assignment
- This is important for assessing improvement measures
- Delay studies provide data for the design and installation of traffic control devices

Time taken by the test vehicle to reach the other end of the stream while it is moving along with the traffic is
tw =0.5/20 = 0.025 hr
Time taken by the observer to reach the other end of the stream while it is moving against the traffic is ta = tw = 0.025 hr

Flow is given by equation,

$$q_{along} = \frac{x_{opposite} + (over\ taking\ the\ test\ car - overtaken\ by\ test\ car)_{along}}{t_{opposite} + t_{along}}$$

$$q = \frac{107 + (10 - 74)}{0.025 + 0.025}$$

$$q = 860 \text{ veh/hr}$$

Average speed of the traffic stream = (distance)/mean time

$$\overline{t_{along}} = t_{along} - \frac{y_{along}}{q_{along}}$$

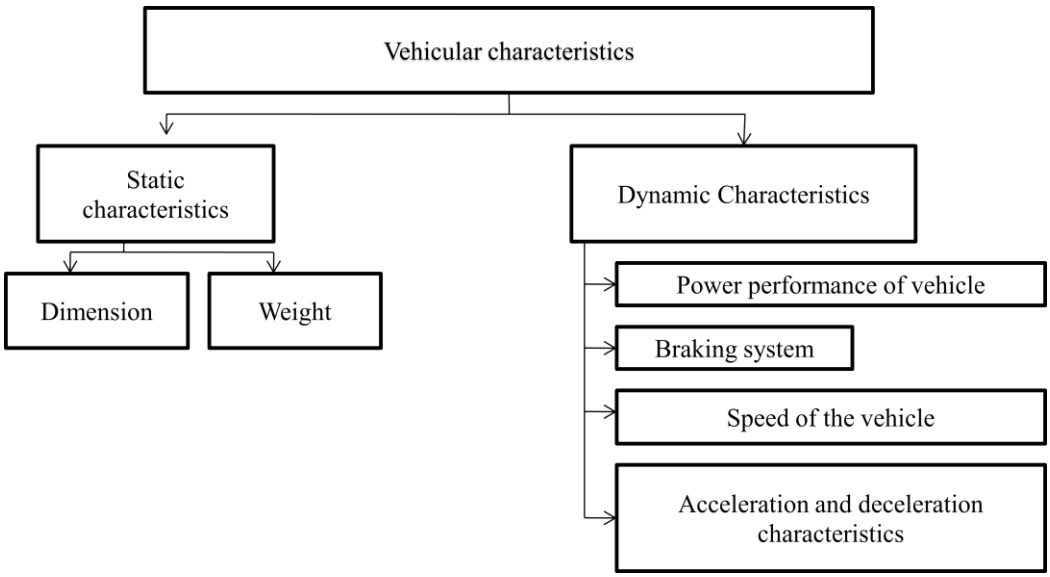
$$\overline{t_{along}} = 0.025 - \frac{10-74}{860}$$

$$\overline{t_{along}} = 0.099\ hr$$

Speed = Distnace/ $\overline{t}$

= 0.5 km / 0.099 hr = 5 km/hr

4b) What are the different vehicular characteristics which affect road design? Explain.



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.

4c) Define (i) Running speed (ii) journey speed (iii) time mean speed (iv) Space mean speed.
Answer)
Running speed: Average speed maintained by a vehicle over a given course while moving. Speed of vehicle while moving.

$$Running\ speed = \frac{Distance}{Running\ time}\ \ (kmph)$$

Journey speed: Average speed maintained by the vehicle during the entire journey. It Includes stops or halts. This speed will never be more than running speed

$$Journey\ speed = \frac{Distance}{Journey\ time}\ \ (kmph)$$

Space mean speed: The space mean speed also averages the spot speed, but spatial weightage is given instead of temporal.
Space mean speed for n no of vehicles moving at a speed of v_i can be given by the following equation

$$Space\ mean\ speed = \frac{n}{\sum_{i=1}^{n}\frac{1}{v_i}}\quad (kmph)$$

Time mean speed: Time mean speed is the average of all vehicles passing a point over a duration of time. It is the simple average of spot speed.

$$Time\ mean\ speed = \frac{1}{n}\left(\sum_{i=1}^{n} v_i\right)\quad (kmph)$$