WINTER–19 EXAMINATION

MODEL ANSWER **Subject Code** **22507**

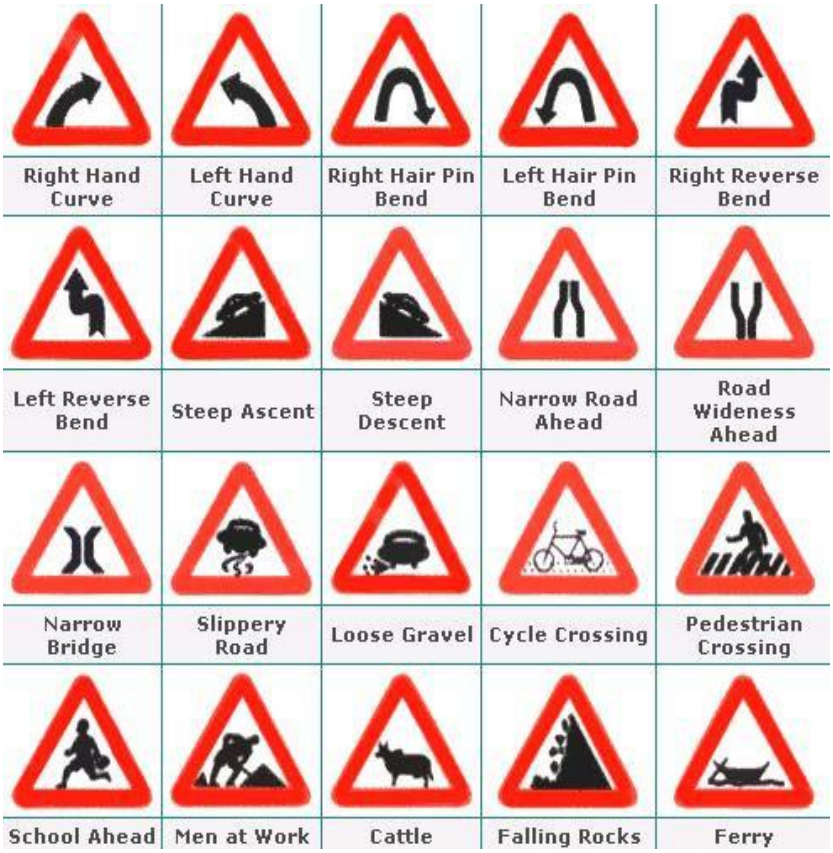
Subject: Traffic Engineering

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors etc… should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Que. No.	Sub Que.	Model Answer	Marking Scheme	Total Marks
1		**Attempt any FIVE of the following:**		10
	a) Ans.	**Define Traffic engineering** The phase of highway engineering which deals with planning and geometrical design of Roads, streets, adjoining lands with traffic operations for safe convenient and economic transportation of persons and goods is called as Traffic Engineering.	2	
	b) Ans.	**Write the essential road characteristics to be considered in traffic engineering.** **The essential road characteristics to be considered in traffic engineering are as follows:** i) Gradient ii) Curve of road iii) Design speed iv) Friction between road and tyre surface	½ mark each	
	c) Ans.	**Give the purposes of traffic studies.** i) To collect the data about type and volume of traffic at present and to estimate the same that the road is expected to carry in near future. ii) To determine the existing facilities such as traffic regulation and control intersections etc provided on roads so as to decide the priority for improvement and expansion of any particular road and to allot the funds accordingly. iii) To decide the pavement thickness of the road. iv) To decide the geometrical design of the road. v) To decide the drainage system, bridges, culverts etc.	1 mark each (Any two)	

		vi) To redesign the road width, curves, traffic signals, intersections from the data collected after traffic survey relating to accidents. vii) To estimate the amount of road taxes that can be levied.		
1	**d) Ans.**	**List out the traffic controlling devices.** **The types of traffic controlling devices are as follows:** i) Traffic signs or Road signs ii) Traffic markings or Road markings iii) Traffic signals iv) Traffic Islands	**½ mark each**	
	e) Ans.	**Write the types of signals to be provided on road.** **The types of traffic signals to be provided are:** i) Traffic Control Signals: a) Fixed time signal b) Manually operated signal c) Traffic actuated signal ii) Pedestrian signal iii) Special traffic signal	**2**	
	f) Ans.	**List out the factors affecting reaction time of driver.** **The factors affecting reaction time of driver are:** a) Physical and Psychological characteristics of driver b) Type of the problem involved c) Environmental condition d) Temporary factors (Eg: Motive of trip, Travel speed, Fatigue, Consumption of alcohol)	**½ mark each**	
	g) Ans.	**Classify the traffic markings.** **Traffic markings are follows:** 1. Carriageway marking or pavement marking 2. Kerb marking 3. Object marking 4. Reflector marking or unit marking	**½ mark each**	
2		**Attempt any THREE of the following:**		**12**
	a) Ans.	**Describe the necessity of origin and destination study.** Necessities of origin and destination study are: i) To judge the adequacy of existing routes and to use in planning new network of roads. ii) To plan transportation system and mass transit facilities in cities including routes and schedules of operation. iii) To locate Expressway or major routes along the desired lines. iv) To establish preferential routes for various categories of vehicles including bypass. v) To locate terminals and to plan terminal facilities. vi) To locate new bridge as per traffic demands. vii) To locate intermediate stops of public transport. viii) To establish design standards for the roads, bridges and culverts along the route.	**1 mark each (Any four)**	

2	b) Ans.	**Draw any two each of regulatory signs and cautionary signs.** **Regulatory Signs:**  	**2 (Any two)**	**4**

		Cautionary Signs:  	**2** **(Any two)**	
	c) **Ans.**	**Explain the uses of various carriage way markings.** The uses of various carriage way markings are: **i)** **Center line marking:** They are provided on two way roads to separate the streams of traffic moving in opposite direction. **ii)** **Traffic lane marking:** They are provided on multilane road to guide the traffic and to properly utilize the carriageway. **iii)** **No passing zone marking:** They are provided to indicate to the road users that overtaking is not permitted in that much portion of the road. **iv)** **Pedestrian crossing or cross walk line:** They are provided at places where pedestrians have to cross the road. **v)** **Stop lines:** They are provided near the pedestrian crossing to indicate to the driver to stop and then to proceed when signal is green. **vi)** **Markings at approaches to intersections:** They are provided near intersections to designate proper placement of vehicles before turning to different directions. **vii)** **Parking space limit marking:** They are provided for proper utilization of parking facility. **viii)** **Obstruction approach marking:** They are provided to indicate that there is some obstruction in the form of monument within the carriageway so as to prevent vehicles from colliding with the obstruction.	**1 mark each** **(Any four)**	**4**

	d) Ans.	**Write the points to be considered while erecting road signs.** The points to be considered while erecting road signs are: i) The signs should be placed on the left hand side of the road. ii) Road sign should normally be placed at right angles to the pavement and facing the approaching traffic except in case of parking signs. iii) In location where the traffic sign may obstruct the vision to pedestrians, they should be mounted at a height of not less than 2.15m above the crown to the lowest edge of the sign. iv) The sign faces should normally be kept vertical, but on gradient it may be desirable to tilt a sign to improve the visibility. v) On kerbed road, the bottom edge of the lowest sign should not be less than 2m above the kerb and on unkerbed roads, the same should not be less than 1.5m above the crown of the pavement. vi) On kerbed roads, extreme edge of the sign adjacent to highway, should not be less than 60cm away from the edge of the kerb.	**1 mark each (Any four)**	
3		**Attempt any THREE of the following:**		**12**
	a) Ans.	**Compare the fixed time signals with manually operated signals.**	**1 mark each**	**4**

Fixed time signals	Manually operated signals
1. These are pre-time signals which are set to repeat regularly a cycle of red, yellow and green lights.	1. These signals are those in which timings of the phase and cycle are changed according to traffic demand.
2. Traffic personnel is not required.	2. Traffic personnel is required.
3. It is suitable where traffic demand on different routes remain constant throughout the day.	3. It is suitable where traffic demand on different routes changes during the day.
4. Initial cost is high.	4. Less expensive.

	b) Ans.	**Enumerate the advantages and disadvantages of grade separated intersections** **Advantages:** i) Grade separated intersections provide maximum facility to the crossing traffic and avoid accident while crossing.	**2 (any**	**4**

		ii) They provide increased safety for turning traffic. By introducing indirect interchange ramps, even right turn movements can be made quite easy and safe. iii) They provide an overall comfort and convenience to the motorist and saving in travel time. iv) Grade separation is an essential part of controlled access highway like expressway and freeway. **Disadvantages:** i) They are very costly in their construction in order to obtain complete grade separation and interchange facilities. ii) Their construction is costly, difficult and undesirable where there is a limited right of way or topography is not favorable. iii) They may cause undesirable crests and sags in vertical alignment in flat or plain areas.	**two)** **2 (any two)**	
	c) Ans.	**Describe the factors affecting visibility of road at night time.** Factors affecting visibility of road at night time are: i) **Amount and distribution of light**: The distribution should be downwards so that high percentage of light is utilized for illuminating the pavement and the adjacent area. ii) **Size of object**: Small objects are less visible as compared to big objects with the reflection of light. iii) **Brightness of object**: When the brightness of the object is less than the background, object appears darker than the road surface. Therefore, brightness of the object should always be more than the background. iv) **Brightness of background**: Brightness of the background should be less than the brightness of the object. v) **Reflecting characteristics of pavement surface**: Usually concrete roads are preferred over bituminous roads because of its good reflecting property. vi) **Glare on the eyes of driver**: Artificial lights of the car, direct sunlight causes difficulty and gives impair vision. vii) **Time available to see the object**: To perceive an object, the physical and mental condition of driver plays a vital role.	**1 mark each (Any four)**	
	d) Ans.	**Write the objectives of road arboriculture.** The objectives of road arboriculture are: i) To provide attractive landscape on the roadside. ii) To provide shades to the road user.		

		iii) To interrupt the annoying sound waves and fumes from road vehicles. iv) Prevention of glare from the headlight of incoming vehicles. v) To provide Job to local people. vi) To lessen the impact of noise pollution caused due to increase in number of vehicles. vii) We get fruit bearing trees and timber. viii) To decrease the impact of air pollution and dust.	**1 mark each (Any four)**	
4		**Attempt any THREE of the following**		**12**
	a) Ans.	**Discuss the factors affecting selection of type of roadside trees.** Factors affecting selection of type of roadside trees are: i) Trees selected should be such that it provides a large and dense crown with beautiful and uniform shape. ii) Trees must be able to resist heavy wind blows and heavy storms. iii) They must suit the soil and climatic conditions of the site. iv) The trees which demand less amount of water should be preferred to those which require frequent irrigation. v) They should be able to produce valuable small fruits, timber and other useful products. vi) Trees should be able to withstand lopping and pruning. vii) They are chosen on the basis of physical growth, shape and size, growth rate, branching pattern etc. viii) Trees like Gulmohar, Ashoka can be planted for landscaping on highways.	**1 mark each (Any four**	
	b) Ans.	**Suggest the preventive measures to prevent road accidents.** Following measure/remedies are suggested to prevent road accidents: - 1) Engineering Aids 2) Enforcement Aids } Three E's 3) Educational Aids **Engineering Aids/Measures** 1. By checking and Redesigning the Road geometrics, if necessary (sight distance, width of pavement, Horizontal alignment, vertical alignment) 2. By providing Required Traffic control devices (signs, Markings, signals, islands) 3. By providing proper pedestrian crossing neatly lined in white colors for pedestrians to cross the road. 4. By providing footpaths along both sides of the Road subjected to heavy intensity of Traffic in urban areas. 5. By segregation of Traffic on urban roads subjected to heavy intensity of traffic. 6. By improving road Intersections with the provision of traffic signals, rotary, channeling islands or grade separations. 7. By providing adequate lighting especially at road intersections. 8. By "Before & After" studies of Road accidents.	**1** **1**	

		Enforcement Aids: Traffic police should be engaged on important and busy road junctions to guide the vehicles. Traffic police should also be given power to prosecute drivers for committing traffic offenses, breaking the rules, driving at excessive speeds, disobeying the signals, driving on wrong sides & making wrong turns. - Speed control. - Traffic control devices. - Training & supervision (License, Driving schools) - Medical check (Tested for vision once in 3 years) - Observance of law & regulation. **Educational Aids:** Road users should be educated so as to know the importance of cultivating road manners & road senses. - Rules of Road - Correct manner of crossing - Posters & slide shows regarding safety should be displayed - This knowledge should also be given to children, schools, parents	**1** **1**	
	c) Ans.	**Describe the points to be considered for road safety.** Points to be considered for road safety are: 1) The road should be designed to proper standards, built to the correct specifications & maintained adequately. 2) The safe speed at which the Vehicle can negotiate a curve depends on the Radius of curvature of the curve. Sharp curves permit low speeds & large Radii curves cater high design speeds. 3) For a Vehicle to negotiate any curve at the desired speed, the road should have adequate super elevation. Deficiency of super elevation can cause serious Accidents. 4) The Minimum carriageway width for two-way road should be 7m to cater for 2 lanes of Traffic. 5) Properly designed & Maintained Road signs inform the driver of need for caution & can avoid accident. 6) Guard Rails and safety barriers prevent vehicles form going off the Roadway in the event of loss of control. 7) Improved visibility & good street lighting also reduces the number of Accidents to about 30%. 8) Channelization Islands Reduces the number of Collision points & hence promotes safety.	**1 mark each (Any four)**	**4**
	d) Ans.	**Explain the method of recording and reporting of an accident.** There are three steps involved: I) Collection of Accident data II) Accident Report III) Accident Records	**1**	**4**

I) Collection of Accident data:

a) General: Date, Time, Persons involved in the accident, classification of accidents like fatal, serious, minor etc.

b) Location: Description & details of location of accidents.

c) Details of vehicles involved: Registration number make, description of vehicles, loading details, vehicular defects**.**

d) Nature of accident: Condition of vehicles involved, details of collision & pedestrians or objects involved, damages, injuries, causality etc. **1**

e) Road & Traffic conditions: Details of Road geometrics, whether the road is straight or curved, surface characteristics such as dry, wet, slippery, Traffic condition - Type of Traffic, Traffic density etc.

f) Primary Causes of accidents: Various possible causes and the primary causes of the accident.

g) Accident Costs: Total cost of the Accident computed in terms of rupees of the various involvements like property damage, personal Injuries & causalities.

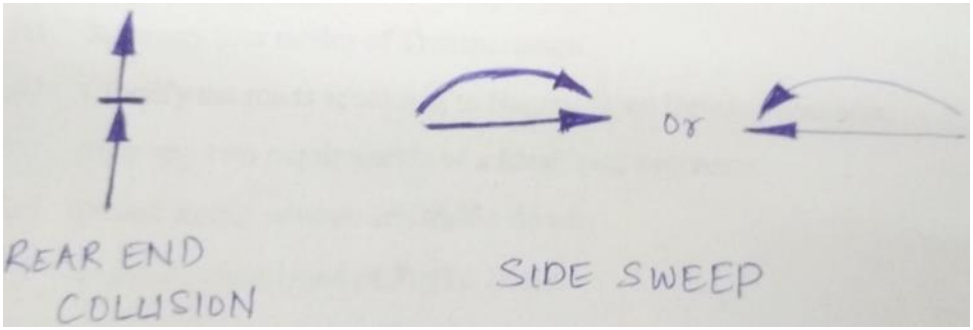
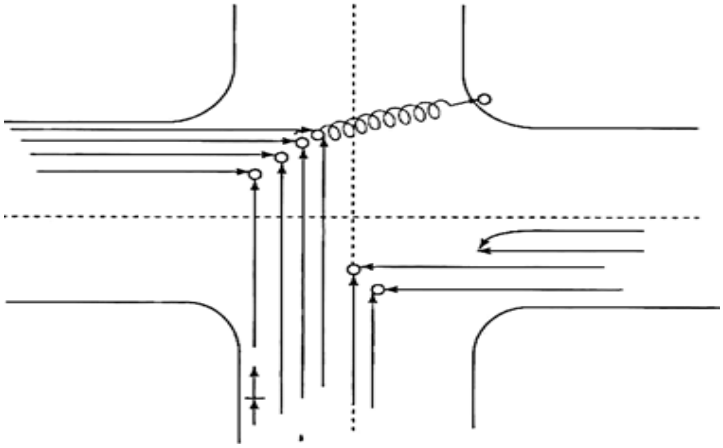
II) Accident Report:

The accident should be reported to police authority who would take legal actions especially in more serious accidents involving injuries, causalities, or severe damage to property. Accident report of the individuals involved may be separately taken. The accident data should be collected & Accident report is prepared with all facts which might be useful in subsequent analysis, claims for compensation etc. **1**

III) Accident Records: **1**

The Accidents Records are maintained giving all particulars of the Accidents, Location etc. The records may be maintained by means of location files, spot maps, collision diagrams & condition diagrams. Condition diagram is a drawing to scale showing all important physical conditions of an accident location to be studied.

Important features generally to be shown with dimensions are Roadway limits. Curves, Kerbs lines, Bridges, Culverts, Trees, Obstruction to Vision, Property lines, Signs, Signals. Collision diagram are the diagrams showing the Approximate path of vehicles & pedestrians involved in the Accidents. Collision diagrams are most useful to compare the Accident pattern before & after the Remedial Measures have been taken.

	e) **Ans:**	**Draw the collision diagram for the following cases.** **i) head on collision of two vehicles** **ii) strucking of vehicle on another moving vehicle** **i) Head on collision of two vehicles**  **ii) Strucking of vehicle on another moving vehicle**  **OR** 	**2** **2** **OR** **2**	

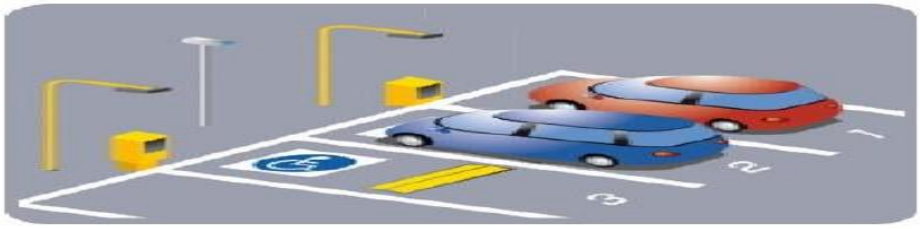
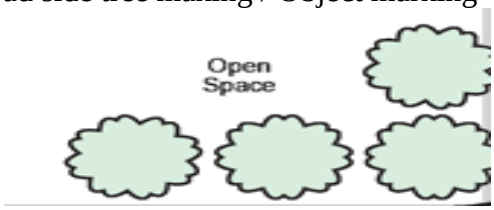
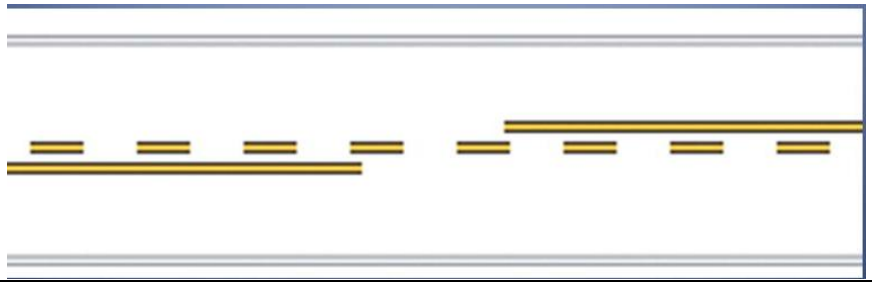
5		**Attempt any TWO of the following:**		**12**
	a)	**Describe the procedure of traffic volume count on any road intersection. Also write the method of representation of traffic volume count data.**	**4**	
	Ans.	The procedure of traffic volume count can be done by any of the methods below: a) Manual counting b) Automatic recorders c) Moving car method **a) Manual counting:** In this method, the members of field team collect the necessary information on the prescribed record sheets at the selected points of road-way. The main advantage is that the field team can record the type and direction of vehicles. However, it is not practicable to do manual counting for all the 24 hours of the day and all the days around the year. This is done manually and the observations are recorded on the following sheet:		

Field sheet for Manual Traffic Counts

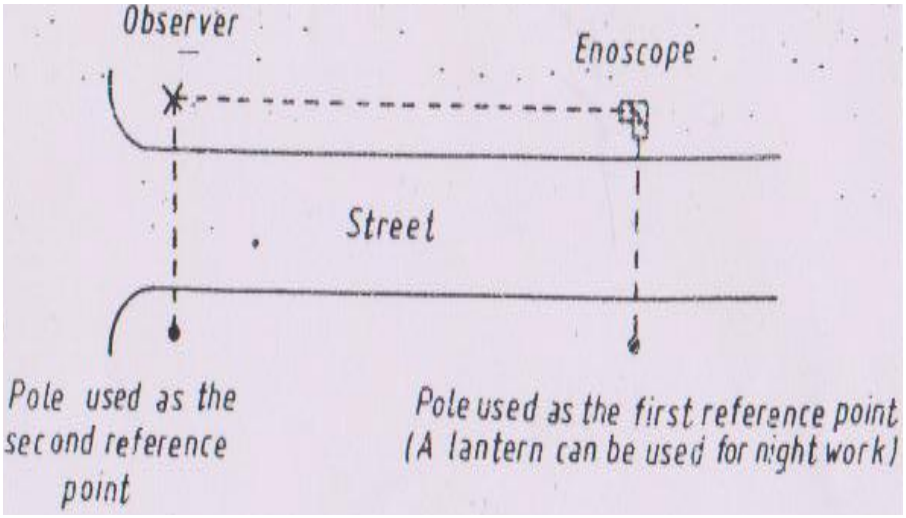
Date of traffic counts:	
Road Classification:	Location of Junction:
Hours Starting:	Hours Ending:
District:	State:

Type of Vehicle	Left turning		Straight Going		Right Turning	
	Enumeration	Total	Enumeration	Total	Enumeration	Total
Trucks						
Buses						
Jeeps						
Cars						
Vans						
Three wheeler						
Motor cycles						
Cycles						
Animal driven vehicles						
Any other						

		b) Automatic recorders These are mechanical counters which can record automatically the total number of vehicles passing a section of a road in the specified time. They may be either fixed type or portable type. The main advantage is that one can work day and night for the desired period recording total hourly volume of traffic. The disadvantage is that they cannot record the type and direction of vehicles. They may record the data by following methods: a) Photoelectric cell method b) Electrical method c) Pneumatic method **Methods of representation of traffic volume count data:** i) Annual Average Daily Traffic volume (AADT) ii) Volume flow diagrams at intersection iii) Variation charts iv) Traffic flow map v) Traffic trend charts **(Note 1: Explanation of any one method of procedure of traffic volume count to be written.** **Note 2: If the students have written explanation of any one method of representation of traffic volume count data, marks should be given)**	**2**	
	b) **Ans.**	**Suggest the road markings for the following and show it with sketch** **i) road side Parking** **ii) road side tree** **iii) Overtaking not allowed on road** **i) road side Parking:** Parking space limit	**1** **1** **(Any one)**	**6**

		  **ii) road side tree:** Road side tree making / Object marking  **iii) Overtaking not allowed on road:** No passing zone marking 	**1** **1** **1** **1**	
	c) Ans.	**Discuss the method of spot speed studies on a road section** i) The simplest method of finding spot speed is by using endoscope. ii) The observer is stationed on one side of the road and starts a stopwatch when a vehicle crosses that section iii) An endoscope is placed at a convenient distance of 50m in such a way that the image of vehicle is seen by the observer when the vehicle crosses the section, where the endoscope is fixed and at this instant, the stop watch is stopped. iv) Thus the time required for vehicle to cross the known length is found	**4**	**6**

and converted to the speed in km/hr.



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OR

OR

There are three methods: 4

A) Average speed of vehicles
B) Cumulative speed distribution method
C) Modal average method

A) Average speed of vehicles:

From the spot speed data of the selected samples, frequency distribution table of spot speed data is prepared by arranging the speed groups covering desired speed ranges and the number of vehicles in such speed range. The arithmetic mean of the measured speeds is taken as the average spot speed of all the vehicles in the stream. The table gives the general information of the speeds maintained on the section and also regarding the speed distribution pattern. 2

Speed range, kmph	Mean speed observations	Frequency f	Percent frequency
1	2	3	4
0 – 10	5	0	0.0
10 – 20	15	11	1.6
20 – 30	25	30	4.4
30 – 40	35	105	15.3
40 – 50	45	233	33.9
50 – 60	55	216	31.4
60 – 70	65	68	9.9
70 – 80	75	24	3.5
80 - 90	85	0	0.0
Total:		**687**	**100.0**

OR

4

B) Cumulative speed distribution method:

A graph is plotted with the average values of each speed group on the X-axis and the cumulative percent of vehicles at or below the different speeds on the Y-axis. The 85th percentile speed' is determined i.e., the speed at or below which 85 percent of the vehicles are passing the point on the highway can be assessed, only 15 per cent of the vehicles exceed this speed at that spot. The drivers exceeding 85th percentile speed are usually considered to drive faster than the safe speed under existing conditions. Hence this speed is adopted for the 'safe speed limit' at this zone. However, for the purpose of highway geometric design 98 th percentile speed is taken. The 15th percentile speed represents the lower speed limit, to prohibit slow moving vehicles to decrease delay and congestion.

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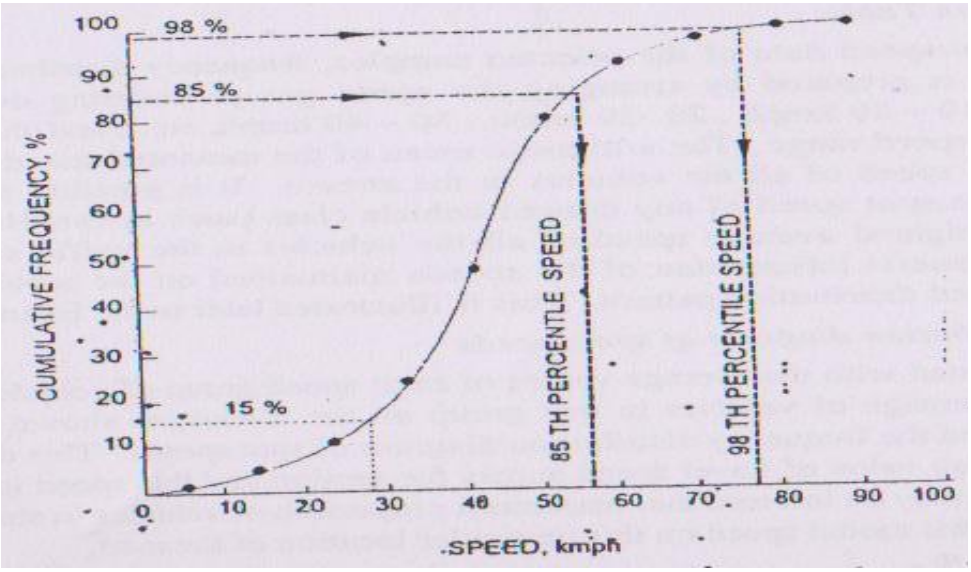

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C) Modal average method:

- A Frequency distribution curve of spot speed is plotted with speed of vehicles on X axis and the percentage of vehicles in that group on Y axis.
- This graph is called Speed distribution curve.
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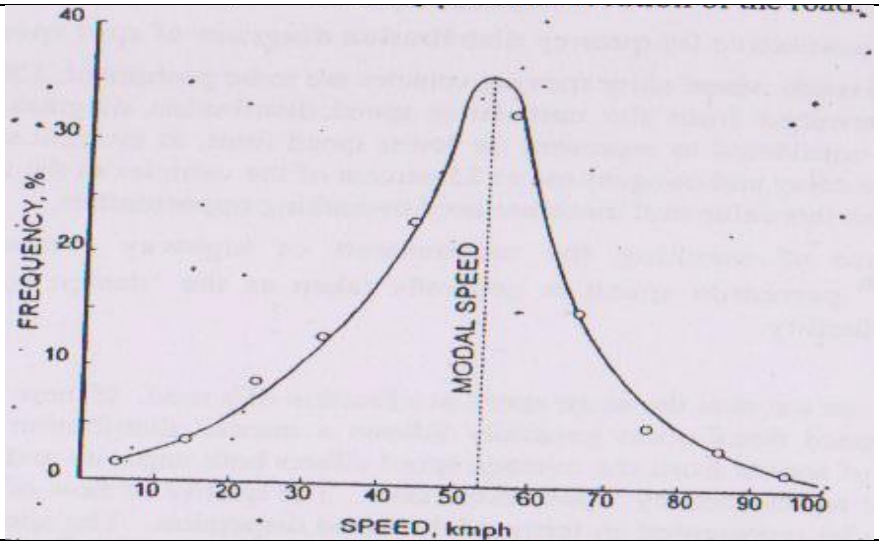
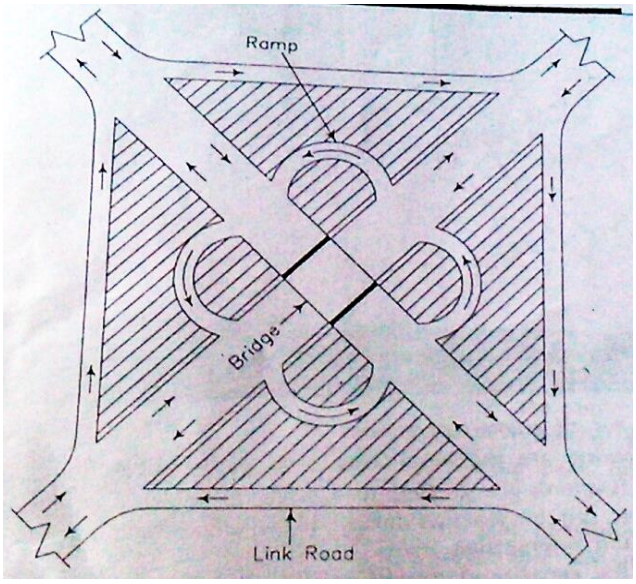
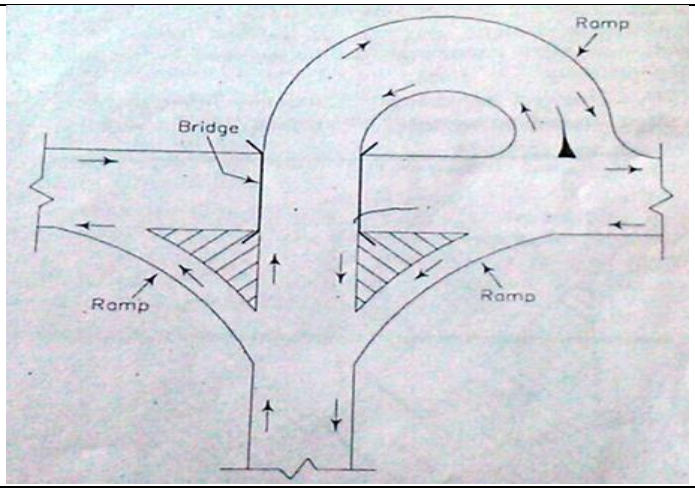
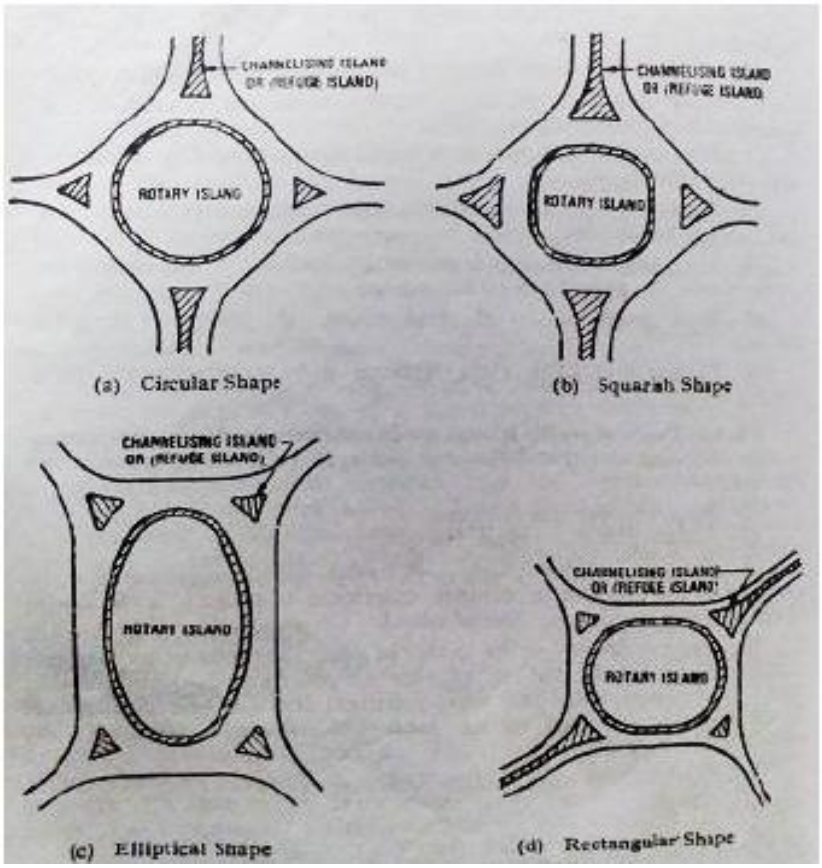


6.		**Attempt any TWO of the following:**		**12**
	a)	**Draw the following road intersections showing traffic flow pattern on it** **i) Cloverleaf pattern** **ii) Trumpet type**		
	Ans.	**i) Cloverleaf pattern**  **ii) Trumpet type:**	**3**	

			**3**	
	b) Ans.	**Discuss the legislation and law enforcement education in road accident studies**. **Various Legislative Measures have been adopted like** 1. Age limit of drivers 2. Penalties of fine on License for careless driving. 3. Enable Police to check the drivers for the drunkenness. 4. Prescribe Rules for cyclists. 5. Prescribe Rule for Motorcycle & Scooter Riders. 6. lay rules for parking of vehicles. 7. Control loading & unloading of goods. (Size & weight of vehicles) 8. To make third party Insurance compulsory. **Law enforcements.** 1. Legislation by itself cannot be able to archive its objective unless it is enforced rigidly. 2. The enforcement is in the hands of police department in cooperation with Traffic courts. 3. The Police force should be adequately strengthened to deal with detection. 4. The work of the police is Rendered easy in cases of detection of offenses such as exceeding speed limits by Mechanical aids. 5. The Radar speed measuring instrument can reward the speed Instant 6. Breath Analysis can detect the drunken driver. 7. Police Patrols in Vehicle equipped with wireless phones are of great help. **Education** 1. It is very essential to educate the Road users for the various measures to use the roadway facilities with safety. 2. The passengers & pedestrians should be taught the rules of the road, correct manner of crossing etc. 3. By introducing necessary instructions in schools for children. 4. Posters exhibiting serious results due to carelessness of road users can be useful.	**2 marks (Any four)** **2 marks (Any four)** **2 marks (Any four)**	**6**
	c)	**Explain with sketch:** **i) Rotary island** **ii) Channelizing island**		**6**

	Ans.	 **Diagram for Rotary and Channelizing Island** **a) Rotary Island:** A traffic island constructed in the center of an intersection to force the movement of traffic in the clockwise direction is called Rotary Island. They are constructed at the center of road intersection to eliminate points of direct conflict and to provide orderly organized traffic flow. They are provided only when sufficient area of construction is available. They are usually of circular, square, rectangular and elliptical shape. **b) Channelizing Island:** Traffic islands provided at the entries and exits of a traffic rotary are called channelizing islands. It is used to guide the traffic into proper channels through the intersection area. It is useful as a traffic control device for intersection at grade when the area is large. Size and shape of channelizing island will very much depend upon the layout and dimensions of the intersection.	**2 (Any one diagram showing both islands)** **2** **2**	