Code No.2742/CBCS

FACULTY OF ENGINEERING

B. E.(Comm.to All) (CBCS) VII – Semester (Main) Examination, December 2019

Subject: Road Safety Engineering (Elective – III)

Time: 3 hours ss Max. Marks: 70

Note: Answer all questions from Part-A. Answer any FIVE questions from Part-B. Missing data, if any, may suitably be assumed.

PART – A (20 Marks)

1. Write the formula of empirical Bayes method.
2. List out various computer applications for analyzing of accident data.
3. What do you mean by vehicle design factor?
4. Discuss various safety counter measures in design of road.
5. What are the various factors affecting signal design.
6. Bring out the points of difference between fixed and vehicle actuated signal.
7. Write short notes on traffic calming schemes.
8. Explain briefly Legislation & Enforcement in Traffic management.
9. List out various characteristics of traffic incidents.
10. Explain briefly the various applications of ITS in Incident management.

PART – B (50 Marks)

11. (a) Explain about the classification of traffic signs with net sketch.
    (b) Discuss travel demand management.
12. (a) Enumerate various statistical methods of analysis of accident data. Explain any two methods.
    (b) Discuss the parking enforcement and its influence on accidents.
13. Explain the Relevance of systems of Intelligent Transportation System (ITS) in the present scenario.
14. (a) Draw the typical illusion diagram of road accident. Specify all the relevant details to analyze it.
    (b) Discuss the various probable causes of road accidents.
15. (a) Explain national importance of survival of transportation systems during and after all natural disasters.
    (b) What are the needs of traffic signal? Discuss various factors affecting signal design.
16. (a) Discuss latest tools and various techniques used for road safety and traffic management.
    (b) Explain parking enforcement and its influence on accidents.
17. Write short notes on
    (a) Traffic impact attenuators.
    (b)Planning effective incident management program.
    (c) Road Safety Audit.

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Road Safety Engineering

PART-A

1Ans. Empirical Bayes method for estimating safety:

$$\text{Estimate of expected accidents for an entity} = \text{Weight} \times \text{Accidents expected on similar entities} + (1-\text{Weight}) \times \text{Count of accidents on this entity}$$

where $0 \leq \text{Weight} \leq 1$

(weight will depend upon strength of accident record & reliability of SPF

2Ans. Various computer applications for analyzing of accident data:

- HVOSM (Highway Vehicle Object Simulation Model)
- SMAC (Simulation Model of Automobile Collisions)
- CRASH (CALSPAN Reconstruction of Accident Speeds on Highway)
- CAD (Computer Aided Designs)

3Ans. Vehicle Design factors are those factors of a vehicle which affect Road safety.

Ex: Braking System
Vehicle lighting system
Vehicle tyres

4Ans. Various safety counter measures in <u>design of road</u>:

- Superelevation
- Providing proper shoulders
- Footpath
- Safety barriers
- Traffic attenuators

5Ans. Various factors affecting signal design:

- No. of approaching roads
- Width of each lane
- Traffic volume
- Location of signal
- Pedestrian traffic volume.

6Ans.

Fixed time signal	Vehicle Actuated Signal
• simple in construction	• Complex in construction
• Relatively inexpensive	• Relatively expensive
• Inflexible	• Flexible
• No detectors	• Requires costly equipment such as detectors, etc.
* In this, the green periods, cycle lengths are predetermined & fixed duration	* In this the green period varies as per actual traffic demands

7Ans. Traffic calming schemes:

- Widening sidewalks
- providing roundabouts instead of signals
- Raised medians
- providing speedbrakers
- Rumble strips.

8Ans. Legislation in traffic management:

- To stipulate age limit for drivers
- To introduce penalties of fine, imprisonment, disqualification for careless driving.
- To make third-party insurance compulsory.

Enforcement in traffic management:

- Detecting drunker drivers by breath analyzers.
- Using radar speed measurement devices for overspeeding vehicles
- Ensuring proper implementation of legislation.

9Ans. Various characteristics of traffic incidents:

- Highly unpredictable occuring
- Non-recurring event
- Cause large effect on traffic
- Effect economy
- Impacts human lives.

10Ans. Various applications of ITS in incident management:

- Advanced Traveller Information System (ATIS) gives information to Highway users on Traffic jams, road closures, weather conditions, etc.
- Reduces congestion and delay
- Truck transport Management Systems, wherein data on vehicle location, breakdowns and accidents can be analyzed.

PART-B

11Ans. a) The classification of traffic signs with neat sketch:

The I.R.C. Standard of traffic signs comprises of the following cases:

I) Regulatory or mandatory signs:

They inform road users about certain laws and regulations & prohibitions.

Stop and giveway signs:

- This is intended to stop the vehicles on a roadway.
- They are red-in-colour with white border

Prohibitory signs:

- These are meant to prohibit certain traffic movements.
- No parking and no stopping signs:

They are all circular in shape with blue background and red border.

overtaking prohibited

no left turn

No Parking

Speed limit

II) Warning signs / Cautionary signs:

They are used to warn the roadusers of certain hazardous conditions that exist on the roadway. They are in shape of equilateral triangle with apex pointing upwards.

Right hand curve

Right hairpin bend

Narrow bridge

Falling Rocks

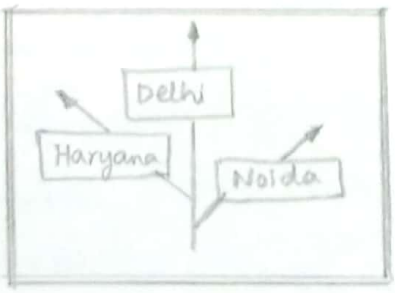
Men at work

Side Road left

III) Informatory signs:

They give information to road users to make their travel easier, safe and pleasant.

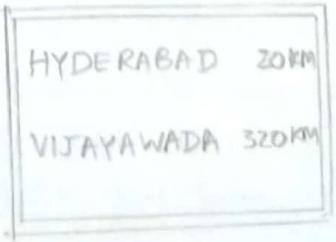
a) Direction and place identification signs
b) Facility information signs
c) Flood gauge signs.



Direction sign

Light refreshment

Public Telephone



11Ans. b) Travel Demand Management:

Travel Demand Management techniques are aimed at reducing the traffic flows, especially during the peak hour. Some of the techniques commonly adopted are:

- Car pooling and other ride-sharing programmes
- Peripheral parking schemes
- Companies offering buses instead of letting employees come by their own vehicles.
- Staggering of office hours, five day work week, flexible time of work, etc can reduce the demand on roads at a single time of day and spreads the demand along the entire day.
- Placing a lot of parking restraints can discourage people from bringing their own vehicles.
- Priority lanes for High Occupancy vehicles. This reduces traffic for buses, vanes causing people to get attracted to public vehicles. It is a behavioural change technique for Travel Demand Management.
- Increasing road taxes and road pricing for private vehicles like cars can also lead to reduction in demand.
- Entry-fee for some special lanes.

12 Ans. a) Various statistical methods of analysis of accident data:

A number of statistical methods are currently being applied in accident research. These include:

i) Regression methods
ii) Poisson distribution
iii) Use of Chi-Squared test for comparing accident data
iv) Quality control methods

ANY TWO OF THE ABOVE TECHNIQUES

Regression Method:

The basic principle behind these methods is that the expected number of accidents, on a certain road system during a given time is dependent in a linear way on significant factors.

The regression model is of the following form:

$$Z = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \cdots + \alpha_n x_k$$

Z = accident rate

$x_1, x_2, x_3 \cdots x_n$ = independent variables

α_0 = regression constant

The regression equation is easy to determine by means of a computer program by method of least squares.

Poisson distribution in accident analysis:

This is appropriate because accidents are governed by laws of chance and the occurance of accidents is a rare event in time or in distance or amongst drivers.

The mathematical formula for Poisson Distribution is:

$$P(r) = \frac{e^{-m} m^r}{r!}$$

$P(r)$ = Probability of occurence of r events

m = average rate of occurence of events

N = Number of drivers

M = Number of Kilometers driven by each driver

p = probability of having an accident per kilometer travelled

$(m = pM)$

Use of chi-squared distribution for comparing accident frequencies:

Before and after data on accidents can be evaluated on statistical principles using Chi-Squared Test. Assuming that improvements have no effect and accident rate is increasing by chance, let bC = No. of accidents without improvements

where C = control factor,

a = actual no. of accidents after improvement

$$\chi^2 = \frac{(a - bC)^2}{(a+b)C}$$

Assuming a 5% level of significance, we have $\chi^2 = 3.841$.

if $\chi^2 \geq 3.841$, null hypothesis cannot be true and changes caused significant decrease in accidents

if $\chi^2 < 3.841$, null hypothesis is true and changes in accident number is due to chance.

Use of Statistical Quality control Approach:

- This has been widely recognized as an effective tool
- This is basically built on Poisson distribution model for occurence of accidents
- From past records on estimate of m, the expected average no. of accidents is made.
- Thereafter confidence limits are determined for any number of accidents
- If observed accidents are greater than this, it can be deduced that there has been significant change in accident causation.

12Ans b) Parking and its influence on accidents

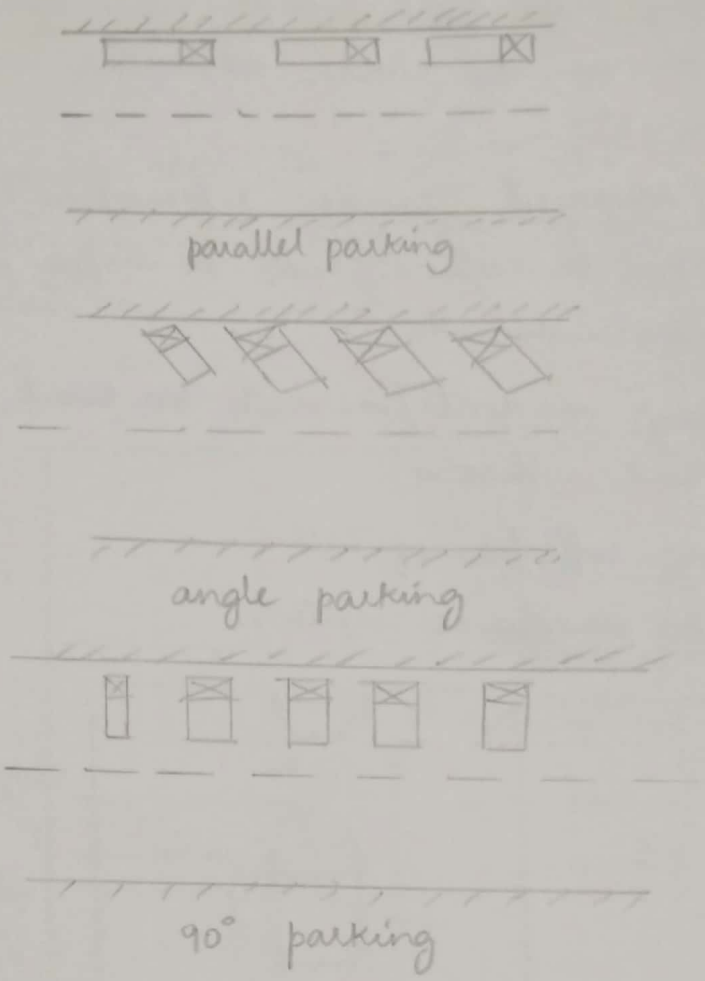
- Parking and unparking of vehicles can cause accidents to pedestrians, cydists, etc.
- Opening of car doors during parking can suddenly cause accidents to pedestrians or cyclists
- Pedestrians can appear from between parked vehicles or in front of a vehicle parked, unnoticed by a speeding vehicle.
- Parking generally reduces the street space and it increases congestion, thereby causing accidents.

Types of parking facilities

- Onstreet parking
  - parallel parking
  - angle parking
- Off street parking

when width of road is less, opstreet parallel parking can be preferred.

The use of angle parking can be made when thereare more no. of vehicles to park.



13Ans. Relevance of systems of Intelligent Transportation Systems (ITS) in present scenario.

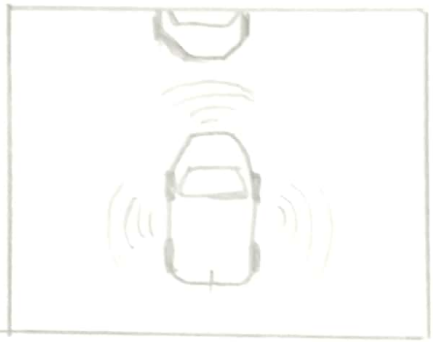
ITS are transport systems that apply modern information technologies to improve the operation of transport networks

These systems aquire vast volumes of data on various aspects and proces them and apply the result to guide traffic, improve operations and enhance safety.

ITS uses

- motorists infomation
- equipment

- Monitoring traffic flow, provide information to drivers on congestion on the roads, alternative routes, weather conditions, etc.
- ATIS (Advanced Traveller Information System) gives information to highway users on traffic jams, road closures, alternative routes, etc.
- Monitoring accidents/incidents on road, such as vehicle break-down and collisions
- Electronic collection of Toll
- Collision avoidance systems



stops collision when it senses another vehicle approaching

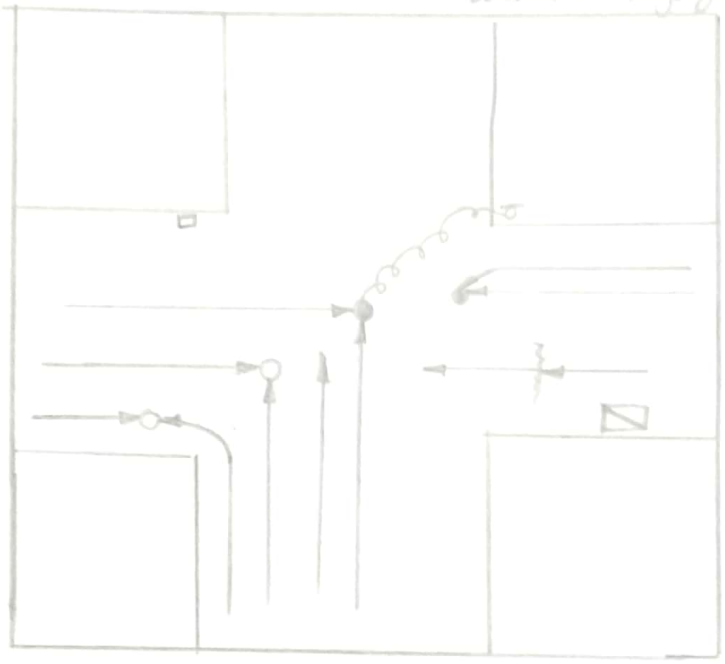
- Intelligent Vehicle Highway systems (IVHS) in which vehicles are guided longitudinally and laterally by use of electronic devices.
- Advanced Vehicle Control Systems (AVCS) dispense the human control of vehicles and rely on computers
- Public transport Management Systems where in the fleet can be managed by efficiently analyzing data on vehicle location, passenger loading, etc
- Truck transport management systems where the data on vehicle location, breakdown, accidents can be analyzed.

ITS is the need of the hour in modern transportation systems for Traffic, Trasport Management.

14Ans. a) Typical collision diagram and all the relavant details to analyze it:

These diagrams show the path of vehicles and pedestrians involved in accident. They are used in recording accident data.

Date: 01-01-2001 Time: 18:30
Location: Panjagutta 'x' roads, Hyd.



- motor vehicle moving ahead
- motor vehicle parking
- pedestrian movement
- parked vehicle
- rear end collision
- head on collision (left turn)
- out of control
- Personal injury
- Fatal accident
- Right angle collision
- side swipe
- fixed object

14Ans b) Various probable causes of road accidents:

Type of accident:	Probable Cause:
• Left turn head on collision	a) Large volume of left turns b) Restricted sight distance c) Too short amber phase d) Absence of special left turning phase e) Excessive speed on approaches.
• Right angle collision at signalized intersection.	a) Restricted sight distance b) Excessive speed on approach c) Poor visibility of signal d) Inadequate signal timing e) Inadequate roadway lighting f) Inadequate intersection warning signs g) Large total intersection volume.
• Rear end collision at signalized intersections	a) Slippery surface b) Poor visibility at signals c) Inadequate signal timing d) Inadequate roadway lighting e) Large number of turning vehicles.
• Side sweep collisions	a) Driver unaware of side turns b) Vehicles not using indicator lamps c) Trying to take turns while overtaking d) Narrow roads
• Pedestrian vehicle collisions	a) Restricted sight distance b) Inadequate protection for pedestrians c) School crossing area d) Inadequate signals.

15 Ans (a) National importance of survival of transportation systems during and after natural disasters

Disasters are extraordinary situations that require significant logistical deployment to transport equipment and humanitarian goods in order to help and provide relief to victims. Following disasters, transportation networks act as key lifelines enabling access to the affected communities and supporting evacuation, emergency response, relief and recovery operations.

In the post-disaster phase, the transportation network may suffer severe damages to its elements (highways, bridges, embankments, tunnels), ranging from degradation to full collapse. These may in turn reduce the network's performance, limit its connectivity or lead to partial loss of functionality.

The "surviving" transportation network will be expected to operate under a completely different operating environment and service needs. An impending disaster

may, for example, force the evacuation of population. The network should be able to handle the large volumes of outbound traffic but at the same time reserve some lanes and routes for emergency response and relief activities. In a later stage, the same network is expected to support recovery but also daily activities until its full restoration.

15 Ans. (b) Needs of traffic signal, Various factors affecting signal design

Need of traffic signal: (1) At intersections in order to avoid accidents & orderly movement of traffic, traffic signals are required. (2) Pedestrians can cross the road safely at signalized intersections. (3) If the signals are properly coordinated, there can be continuous flow of traffic without delays.

Factors affecting signal design:

1. Geometric parameters: No. of approaching roads, lanes etc.
2. Operational characteristics of vehicles: Traffic flow during peak hours etc.
3. Operational characteristics of pedestrians: Pedestrian traffic volume etc.
4. Design volumes: Signal phasing, cycles etc.
5. Air quality: Amount of CO, CO_2 at that place.
6. Constraints of construction: Funding, space etc.

16 Ans a) Latest tools and various techniques used for road safety and traffic management:

- Speed limits:

Establishing speed limits can reduce the number of accidents. These prohibit the drivers from driving a high speeds in important areas such as

→ hospitals → schools → offices

which are generally prone to accidents

- Restrictions on Turning movements:

Congestions and accidents caused by right turning vehicles at signal controlled intersections are usually solved by inserting an extra phase or early cut off of signal cycle.

In some cases, it may be preferred to ban right Turning vehicles at critical intersections during all parts of the day.

- One way streets:

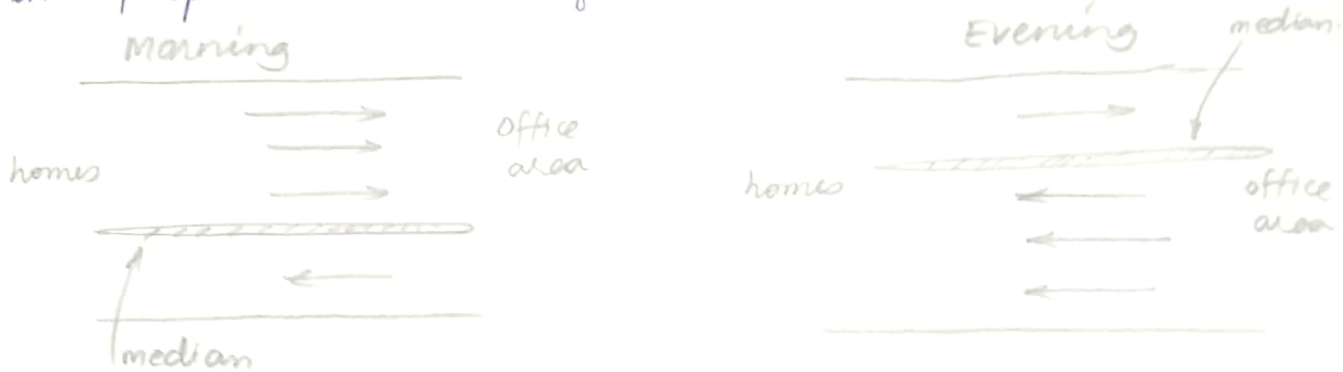
This is one way of reducing congestion & ensuring smooth flow of traffic.

It removes many types of conflicts such as:

→ merging conflicts
→ crossing conflicts
→ Diverging conflicts.

- Tidal Flow operation of major roads:

It is the traffic tool whereby the total carriage-way width is shared between two directions of travel in proportion to the flow in each direction.



- Priority for High occupancy vehicles:

This is done by

→ providing separate bus lanes

→ giving priority for HOV's at intersections

- closing side streets and
- Proper parking control.

16Ans b) Parking and its influence on accidents

THIS IS SAME AS 12ANS B

17 Ans a) Traffic impact attenuators:

- They are required for absorbing the kinetic energy of impact of vehicles that go out of control.
- They are also known as crash cushions
- As shown in the figure, scrap tyres can be used as impact attenuators
- They are used especially during car racing
- They are placed along the road where cars race.

FRONT VIEW

TOP VIEW

AN EXAMPLE OF TRAFFIC IMPACT ATTENUATORS

17 Ans b) Planning effective incident management program:

Effective incident management requires

i) planning ii) Response iii) Safety iv) Recovery

For effective planning:

→ ITS can be used

→ Traffic management techniques can be used.

- Parking inventories have to be managed
- Planning has to be done for response and recovery phases too.
- Ensuring proper legislation and enforcement can reduce accidents and increase safety
- Proper medical facilities must be arranged.

17Ans c) Road Safety Audit

- Road Safety Audit is a formal examination known for preventing road accidents of an existing road or for a future road project.
- The objective of RSA is to identify any aspects of a highway design that give keise to road safety concerns and suggest amendments in the design that would enhance safety.
- It is not a check against standards
- It is a check of complaince with standards
- Road Safety Audit has to be conducted at the following times/stages:
  - → on completion of preliminary design
  - → on completion of Detailed design
  - → on completion of construction

With RSA,
- → No. of accidents on the road can be reduced
- → The severity of accidents can be reduced.