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Internal Assessment Test III – November 2019

Sub:	TRAFFIC ENGINEERING					Sub Code:	17CV561	Branch:	CIVIL	
Date:	19/11/19	Duration:	90 min's	Max Marks:	50	Sem/Sec:	V Sem(Open Elective)		OBE	

PART A is compulsory and answer any **TWO FULL** Questions from **PART B**.
Provide neat sketches wherever necessary. Assume any missing data suitably.

		MARKS	CO	RBT
	PART A			
1 (a)	Define briefly signal "cycle" and "interval". Describe Webster's method of signal design in detail.	[06]	CO3	L2
(b)	What is TDM? List and describe different techniques to achieve TDM	[06]	CO5	L2
(c)	Define TSM and describe its six categories	[06]	CO4	L1
	PART B			
2 (a)	Describe different sources and impacts of air pollutants. Explain briefly various abatement measures to reduce.	[08]	CO4	L2
(b)	Write Design steps for signal design by IRC Method	[08]	CO2	L2
3 (a)	i) Explain ITS for Traffic Management. ii) List Non-motorized transport issues	[08]	CO5	L2
(b)	What is ATC? Describe different components of ATC with a neat sketch	[08]	CO3	L3
4 (a)	What are the different types of coordinated signals? List the advantages and disadvantages of each.	[08]	CO4	L1
(b)	Write short notes on a) one way traffic with advantages and disadvantages b) Design factors of highway lighting	[08]	CO5	L2

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Scheme and Solution

Q1.

(a) Define briefly signal "cycle" and "interval".
Describe Webster's method of signal design in detail. (6)
(b) What is TDM? List and describe different techniques to achieve TDM (6)
(c) Define TSM and describe its six categories (6)

Ans: (a) ***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 . This is the actual duration the green light of a traffic signal is turned on.

Red interval: It is the red indication for a particular movement or set of movements and is denoted by Ri . This is the actual duration the red light of a traffic signal is turned on.

Webster's Method:

Step 1: Calculate Y

Y = y1+y2….

Where y = design flow/ saturation flow

Step 2 : Calculate total lost time

Total lost time = $\Sigma l + \Sigma(i-a)$ or Σl + All red time

Where l : starting delay per phase

i= intergreen period

a= amber period

(If not provided in question, consider i = 4 seconds and a= 2 seconds

Step 3: Calculate optimum cycle length

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

C_0 is always restricted to 120 sec

Step 4: Calculate green time for the phases;

Co-L : Effective green time

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

(b) 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.

Direct method

1. Car pooling and other ride-sharing programmes
2. Peripheral parking
3. Chartered buses
4. Staggering of office hours
5. Internal shuttle service in CBD
6. Parking restraint
8. Entry fee
9. Priority for buses in traffic

Indirect Method

1. Road pricing
   - Principle of road pricing: The principle behind road pricing is that those who cause congestion or use the road in the congested period should be charged, thus giving the road user the choice of whether to make a journey or not.
   - As the price gradually increases, a point will be reached when the trip maker considers it not worth performing or it is worth performing by other means. This is known as the critical price. At a cost less than this critical price, he enjoys a net benefit called as consumer surplus

(c) Traffic System Management/ Transport system Management is the planning, monitoring, and controlling or influencing of traffic modes.

It aims to:

• Maximize the effectiveness of the use of existing infrastructure;
• Ensure reliable and safe operation of transport;
• Address environmental goals; and
• Ensure fair allocation of infrastructure space (road space, rail slots, etc.) among competing users.

The spectrum of TSM measures is wide; the measures that are applicable will generally fall into one of six categories listed below:

1) Regulatory Techniques : This include One way Streets, Reversible Streets, Reversible lanes, Turning Moment Restrictions, Closing Streets

2) Traffic Control Devices: The various traffic control devices used for the traffic management are: Traffic Signs, Traffic Signals, Road Markings, Computerised Signal Control device, Traffic Cone and Drums, Speed Breakers

3) Traffic Segregation Techniques: The various traffic segregation techniques used are Vehicle-Vehicle Segregation, Pedestrian-Vehicle Segregation, Time Segregation

4) Demand Management Techniques: The various demand management techniques used are Parking Restriction, Parking Pricing, Off Street Parking and Pay Area, On street parking meters, Park and ride systems

5) Bus Priority Techniques: The various bus priority techniques used are: Bus Priority Manoevours, Bus Lanes, Bus Priority Signal system

6) Self-Enforcing Techniques: The various techniques used are Central Divider, Railing, Channelizes.

Q2.

(a) Describe different sources and impacts of air pollutants. Explain briefly various abatement measures to reduce (5+3)

(b) Write Design steps for signal design by IRC Method (8)

Ans: (a)

Pollutant	Source	Consequences
NO_2	Vehicular exhaust	It forms smog and ozone, It causes respiratory illness, pulmonary disease, bronchitis etc
CO	Vehicle's exhaust as a result of incomplete combustion, Emissions from trucks, autos are significant	It interferes with the blood's ability to carry oxygen to the brain, heart, and other tissues. Unborn or newborn children and people with heart disease are in greatest danger from this pollutant, but even healthy people can experience headaches, fatigue and reduced reflexes and even death
SO_2	Fuel containing sulfur is burned in diesel engines	Asthma, lung diseases, irritate mucus membrane, bronchitis, pulmonary diseases It can effect plants, animals and also properties
O_3	Secondary formation from the vehicular exhaust gases such as reaction of NO2	It forms smog, ozone reacts with lung tissue. It can inflame and cause harmful changes in breathing passages, decrease the lungs' working ability, and cause coughing and chest pains.
Particulate matter (PM)	Particulate matter includes microscopic particles and tiny droplets of liquid which comes from combustion of the fuel in vehicles	PM are very fine in size and they go deep into the lungs, where they may become trapped and cause irritation. Exposure to particulate matter can cause wheezing, asthma, respiratory illness, PM can serve as a vector for toxic air pollutants which may be carcinogenic
Lead	Lead can emitted from leaded petrol, However, usage of un leaded petrol resulted in significant drop in public exposure to outdoor lead pollution	Lead poisoning can reduce mental ability, damage blood, nerves, and organs, and raise blood pressure. Even small ingestions or inhalations of lead can be harmful because lead accumulates in the body
Hydrocarbons	Vehicular exhaust	Many hydrocarbons are carcinogenic

Abatement measures:

1) Vehicular Emission Norms: Now we are in Bharat stage IV

2) Fuel Quality Specifications:

#Unleaded Gasoline

#Benzene Reduction

#Reduction of sulphur in diesels

3) Alternate Fuels

(i) CNG (Compressed Natural Gas)

(ii) LPG

(iii) Battery driven vehicles

4) Phase out of Grossly Polluting Vehicles

5) Improvement in lubricant oil quality

6) Adequate Traffic Management

7) Improvement in Public Transport System

8) Continuous research on technology improvement of vehicles

9) Mass awareness programs

(b) **Step 1: Calculate the design traffic volume**

– Take highest volume in each approaches

– Find per lane traffic volume

• **Step 2: Calculate Pedestrian crossing time**

G1p= 7 + (width of road/ walking speed) for road 1

G2p= 7 + (width of road/ walking speed) for road 2

Where 7 seconds is the initial walking period, Walking speed = 1.2 m/s

• **Step 3: Calculate Vehicle green time**

For minor road

So vehicular green time of minor road = pedestrian green time of major road

For major road

Now green time of major road = (Design flow in major road/design flow of minor road) * Green time of minor road calculated above

Step 4: Calculate total cycle time

– Add amber time = 2 seconds

– Inter green time = 2 seconds

Total cycle time = (amber time+ green time+ inter green time) for road 1+ (amber time+ green time+ inter green time) for road 2

• **Step 5: Check for minimum green time**

– No of vehicles/ cycle = (total vehicles on road)/ Cycle time = N

– Minimum green time required = 6 + (N-1)* 2 = a PCU (should be less than the calculated green time for the road)

– Here 6 seconds is for first vehicle, rest vehicles takes 2 seconds

– Calculate the same for other road

• **Step 6: Check for optimum signal time using webster method**

– Calculate saturation from the table provides in guideline

– Calculate lost time as = amber time+Inter green time + starting delay

– Amber time = 2 seconds, inter green 2 seconds and starting delay 4 seconds

Q3.

(a) i) Explain ITS for Traffic Management. ii) List Non-motorized transport issues (4+4)
(b) What is ATC? Describe different components of ATC with a neat sketch (1+7)

Ans:

(a) i. 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 road transportation systems.

3 components of ITS

- ITS user services
- ITS architecture
- ITS planning

ITS user services: A framework is developed highlighting various services the ITS can offer to the users. A list of 33 user services has been provided in the National ITS Program Plan.

The number of user services, keep changing over time when a new service is added.

1. Travel and traffic management
2. Public transportation operations
3. Electronic payment
4. Commercial vehicle operations
5. Advance vehicle control and safety systems
6. Emergency management
7. Information management
8. Maintenance and construction management

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.

Interoperability - The ITS architecture should be such that the information collected, function implemented or any equipment installed be interoperable by various agencies in different state and regions.

Capable of sharing and exchanging information - The information by traffic operations may be useful to the emergency services.

Resource sharing - regional communication towers constructed by various private agencies are required to be shared by ITS operations

ITS planning

The ITS planning is to **integrate ITS into the transportation** planning process. Transportation planning is an iterative process which includes **problem identification, solution generation, analysis, evaluation and implementation**. This can be **integrated with ITS using computers, communication systems and software.**

As planning is normally made for long period, installing ITS facilities needs to be updated and one should ensure that the equipments and technologies are compatible for future improvement and expansion.

ii. NMT issues

➢ Define the role of NMT (access only or main mode) in overall mobility of the city (for larger, medium and smaller cities).

➢ Need for change in planning and policy guidelines, to provide seamless travel using NMT.

➢ Development of credible ways to assess the impact of pedestrianization, pedestrian zones, etc.

➢ Ways to integrate hawkers and vendors as part of the pedestrian policy and facility design guidelines.

➢ providing pedestrian facilities and developing standards for the same.

➢ Effective geometric design for NMT to provide seamlessly connected and safe travel across the city.

➢ Identification of factors that may encourage the use of NMT modes in Indian cities.

➢ Understanding the effect of urban density, mixed land uses, neighborhood features, etc. on NMT use.

➢ Understanding the potential of traffic calming in pedestrian safety.

(b) ATC

- ATC systems are intelligent real-time dynamic traffic control systems which are designed to effectively respond to rapid variations in dynamic traffic conditions.
- It is a traffic responsive system that use data from vehicle detectors and optimize traffic signal time in real time.
- The timing plan of traffic controllers changed automatically. The technique employs digital computers for achieving the desired objective

Major building blocks/components of ATC are

1) vehicular detector, 2)Intersection Controller 3) Communication Network 4) Application Software and Central (Regional) Control System

1) Vehicle Detectors -

VD acts as a nodal point between vehicle and intersection controller. Commonly used vehicle detectors are

1. Ultrasonic
2. microwave radar
3. infrared laser radar
4. non-imaging passive infrared
5. video imaging
6. acoustic array
7. magnetic loop
8. Inductive loop

2) Intersection Controller- It placed at intersection for temporary storage of data. It collects the data from vehicle detector and sends it to the central control. Central

control processed the data and sends it back to intersection controller which then implements the signal timings as instructed at the intersection.

3) Communication Network-

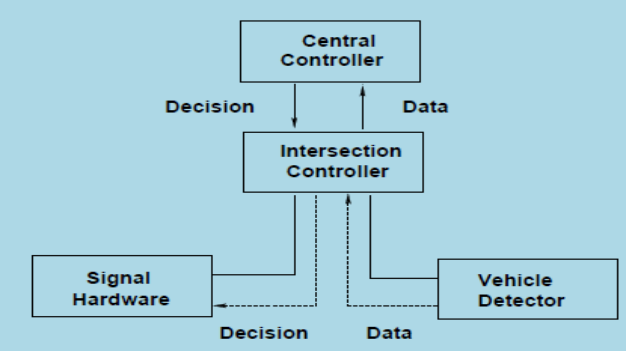
It transfers the data obtained from detectors to central control which then implements the signal timings as instructed at the intersection.

3) Application Software -

This is used behind the whole ACT system which performs the entire task.

4) Central (Regional) Control System-

This is the main unit of ACT. In this unit collected traffic data is processed to optimize various traffic parameters like- signal timing, phase change, delay. it supervises all the units of ACT.



Q4.

(a) What are the different types of coordinated signals? List the advantages and disadvantages of each. (4+4)

(b) Write short notes on a) one way traffic with advantages and disadvantages b) Design factors of highway lighting (4+4)

Ans:

(a) There are 4 types of signal coordination system

1. Simultaneous system
2. Alternate system
3. Simple progressive system
4. Flexible progressive system

Simultaneous system

All the signals along a given street will display the **same indication** to the same traffic stream at the same time.

Division of **cycle time is same** at all intersections

A master controller is employed to keep the series of signals in step.

Disadvantages:

1. It's not conducive to give continuous movement of all vehicles
2. It **encourages speeding** of drivers between stops
3. Since division of cycle time is same at all intersections, **inefficiency** is inevitable at some intersection

4. **Simultaneous stopping** of vehicles at all intersection cause **difficulty** for the side street vehicles while turning.

Alternate system

Consecutive traffic signal installations along a given road show **contrary indications at the same time.**

This permits the vehicles to travel one block in one half of the cycle time.

It brings about a certain measure of **speed control** since speeding drivers are stopped at each signal.

Disadvantages:

1. Green times for both major and minor streets have to substantially equal. Hence, more wastage of time.
2. If the block length is not equal, it's not well suited.
3. Adjustments are difficult for changing traffic conditions.

SIMPLE PROGRESSIVE SYSTEM

- In 'simple progressive system' a time schedule is made to permit, **as nearly as possible, a continuous operation of groups of vehicles** along the main road at a **reasonable pre-decided speed.**
- The signals controlling green phases of the traffic signals along this road are scheduled to work at the predetermined time schedule
- Though each signal unit may work as fixed time signals, they have **equal signal cycle length** and **are interlinked** so as to operate with the required time off-sets.
- The **principle of this simple progressive system is that if a group of vehicles get released during the green phase at a signalized intersection of the main road, by the time the first vehicle of this vehicle group travelling at the recommended speed reaches the next junction, the green phase of this signal would just get started to allow non-stop movement to the next intersection**.

Disadvantages

- However on urban roads the traffic volume at each intersection may very considerably; the number of intersecting roads may also very at different junctions.
- Therefore practically it may not be always possible to provide equal signal cycles at all the intersections along the selected stretch of the main road and so the simple progressive system may not function effectively.

FLEXIBLE PROGRESSIVE SYSTEM

- It is possible **to automatically vary the length of signal cycle** and **signal phase** at each signalized intersection with the help of sensors to detect vehicle arrival and connecting to a master computer.
- This is the **most efficient system** of all the four types of traffic signal system.
- This system can function satisfactorily on selected stretches of urban roads with divided carriageway or on roads with one-way traffic.
- This system is an improvement over the simple progressive system with the following provisions.

(i) It is possible to vary the cycle time and division at each signal depending upon traffic.

(ii) It is possible to vary the offset, thus enabling two or more completely different plans.
(iii) It is possible to introduce flashing or shut down during off-peak hours

One-way streets are those where traffic movement is permitted only in one direction.

Advantages:

1. **A reduction in the points of conflict**: since opposing traffic flow is not there, head on collisions can be avoided and the number of conflict points is reduced.
2. **Increased capacity**: entire traffic in one direction, hence high capacity.
3. **Increased speed**: No opposing traffic, hence high speed.
4. **Ensure smooth and safe traffic**
5. **Improvement in parking facilities**: Only one-side parking. This ensures more space for traffic movement.
6. **Elimination** of dazzle and **head-on-collision**

Disadvantages:

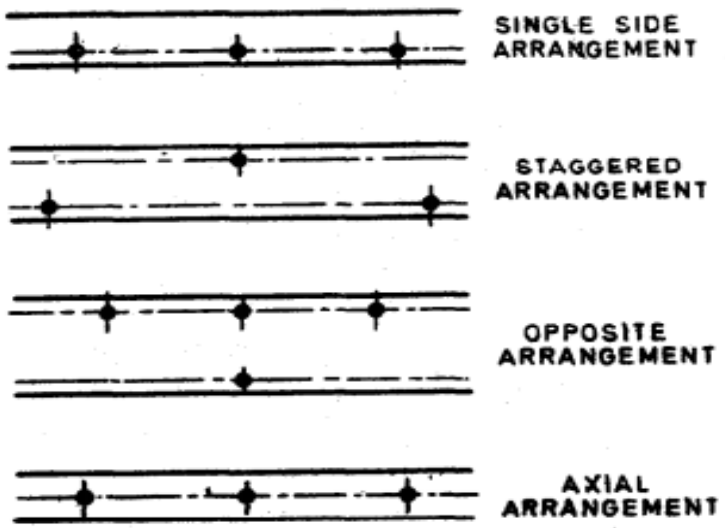
1. Though journey time decrease, actual **distance to be covered increase.**
2. The **relocation of bus-stops** due to one-way street regulation may cause the passengers to travel extra distance.
3. **Excessive speed** of vehicles may be a hazard to residential areas
4. One-way street regulation may become beneficial for some **business** and impart **adverse effect** to others **based on accessibility**.
5. Heavy traffic on one-way streets may affect the peace and tranquillity of the area.
6. **Initially confusion** may set in during traffic operation.
7. **Emergency vehicles** may find it difficult to find gap in other lanes, since there is no traffic flow in opposite direction.

Design factors of highway lighting

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

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