
Transportation Engineering PYQ In-Sem Solution

UNIT 1: HIGHWAY DEVELOPMENT AND PLANNING

1. Explain in brief the salient features of First 20-year road development plan.



This was India's first systematic road development plan, aiming to create a well-connected network to support economic growth and rural development. The key highlights include:

1. **Road Classification:** Roads were divided into five types—National Highways (connecting major cities), State Highways (connecting districts), District Roads (within districts), Village Roads (for rural access), and Other Roads.
2. **Target Road Density:** The goal was to establish 16 km of roads per 100 sq. km to improve accessibility.
3. **Total Road Length:** Planned construction of 132,000 km of roads across India.
4. **Budget Estimate:** The expected cost for the entire project was Rs. 600 crores, accounting for materials, labor, and land acquisition.
5. **Village Connectivity:** No village should be more than 8 km away from a main road, ensuring rural areas could access markets, education, and healthcare.
6. **Grid Pattern Approach:** The roads were planned in a rectangular or grid layout to ensure smooth traffic flow and logical connectivity.

- 7. Implementation Phases:** The plan was executed in two stages:
- Phase 1 (First 10 years) focused on building essential routes.
 - Phase 2 (Next 10 years) aimed at completing the remaining sections.
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2. Explain the classification of roads as per Nagpur Road plan. ★

The Nagpur Road Plan was India's first systematic road development strategy. It categorized roads into five classes:

1. National Highways (NH) –

- Connects major cities and important trade routes.
- Directly managed by the central government.
- Examples: Delhi–Mumbai Expressway, NH44 (longest highway in India).

2. State Highways (SH) –

- Connects district headquarters within a state.
- Maintained by the state government.
- Example: Mumbai–Goa Highway (NH66, partly an SH in Maharashtra).

3. District Roads –

- Links district headquarters to local towns and villages.
- Managed by local authorities.

4. Village Roads –

- Provides connectivity within rural areas.
- Essential for agricultural and rural development.

5. Other Roads –

- Includes private roads, industrial roads, and defense roads.
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3. Explain briefly the requirements of an ideal highway alignment. ★★

A well-planned highway alignment ensures efficient, safe, and economical road construction. The following factors are considered to achieve an ideal alignment:

1. Short & Economical Route

- The highway should take the shortest possible path while minimizing construction costs.
- Avoids unnecessary detours to reduce travel time and fuel consumption.

2. Smooth & Safe Movement

- Should have gentle curves and proper sight distances for safe vehicle operation.
- Designed to minimize sharp turns and sudden elevation changes.

3. Proper Drainage & Stability

- The alignment should be selected where natural drainage is available.
- Avoids low-lying flood-prone areas or unstable soil to prevent damage.

4. Minimal Environmental Impact

- Should avoid forest lands, wildlife zones, and agricultural areas to protect the environment.
- Includes measures to reduce pollution and noise near residential zones.

5. Accessibility & Connectivity

- Connects major cities, towns, industrial hubs, and rural areas efficiently.
- Ensures easy access to public facilities like hospitals, markets, and schools.

6. Future Expansion Scope

- Designed considering future traffic growth, allowing lane additions or expansions.
- Uses proper right-of-way planning to facilitate development.

7. Geotechnical Suitability

- Should avoid landslide-prone areas, weak soils, and steep terrains.
- Selects ground with good load-bearing capacity for stable road foundations.

4. Discuss in brief the various stages of engineering surveys for highway alignment. ★

Highway alignment involves a series of engineering surveys to ensure the road is planned efficiently and fits the terrain. The major stages include:

1. Reconnaissance Survey:

- Initial inspection to study the general terrain.
- Identifies possible routes based on natural and artificial obstacles.
- Helps select a few feasible alignments for further study.

2. Preliminary Survey:

- Conducts detailed measurements using instruments like Total Station & GPS.
- Examines land features, soil conditions, and water bodies.
- Prepares contour maps and longitudinal profiles for comparison.

3. Final Location Survey:

- Determines the exact highway alignment based on survey data.
- Conducts soil testing, hydrological studies, and confirms ground conditions.
- Prepares detailed design drawings for execution.

4. Detailed Engineering Survey:

- Final step before construction, covering earthwork, pavement design, drainage, and environmental impact.
 - Determines land acquisition needs and prepares cost estimates.
 - Ensures practical feasibility of the selected highway alignment.
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5. Explain obligatory points. With sketches, discuss how these control the alignment. ★

Obligatory points are fixed locations that the highway must pass through or avoid due to geographical, social, or environmental constraints. They play a critical role in determining alignment.

Types of Obligatory Points

1. Control Points for Passage:

- Cities, towns, major intersections, or industrial hubs that must be connected.
- Bridges or river crossings that define the road's direction.

2. Control Points for Avoidance:

- Steep terrains, forests, water bodies, or restricted zones (defense areas).
- Religious sites, historical monuments, or wildlife sanctuaries.

Effect on Highway Alignment

- Influences bends & curves: Roads may be designed with smooth curves to reach or avoid these points.
 - Changes road length: Sometimes, avoiding obstacles increases road length but improves safety.
 - Alters construction methods: Steep terrains may require tunnels, retaining walls, or elevated structures.
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6. Enlist the various surveys to be carried out before planning a highway system. Explain any one in brief. ★

Before designing a highway, several engineering surveys are conducted to ensure proper alignment, safety, and efficiency. These include:

- 1. Reconnaissance Survey** – Identifies feasible routes based on terrain and obstacles.
- 2. Preliminary Survey** – Conducts detailed measurements of land features.
- 3. Final Location Survey** – Fixes the highway alignment with precise calculations.
- 4. Traffic Survey** – Assesses vehicle movement and road demand.
- 5. Topographic Survey** – Examines land slopes, water bodies, and elevation.
- 6. Soil Investigation Survey** – Determines soil strength and stability for construction.
- 7. Hydrological Survey** – Studies drainage patterns and flood risks.
- 8. Environmental Survey** – Evaluates ecological impact and mitigation strategies.

Brief Explanation: Reconnaissance Survey

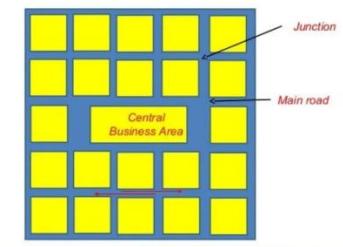
This initial stage helps shortlist possible highway routes before conducting detailed studies. Engineers visit the area to examine existing roads, rivers, hills, forests, and settlements. Simple tools like binoculars, maps, and GPS are used. The goal is to eliminate unsuitable paths and recommend the best alignment options for further investigation.

7. Discuss briefly the various road patterns Draw a neat sketch to justify your answer. ★★

Road networks are planned based on geography, urban expansion, and traffic needs. The common road patterns include:

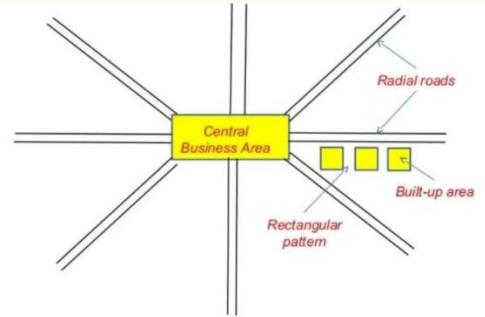
- 1. Rectangular/Grid Pattern**

- Roads are arranged in a square or rectangular format.
- Common in modern cities like New York and Chandigarh.
- Advantages: Easy navigation and structured traffic flow.
- Disadvantages: High number of intersections can slow down movement.



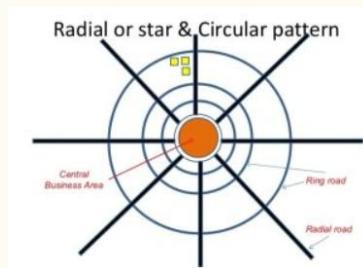
2. Radial Pattern

- Roads radiate outward from a central point, often the city center.
- Common in old cities with historical cores like Paris.
- Advantages: Provides direct access to key locations.
- Disadvantages: Traffic congestion increases as roads converge at the center.



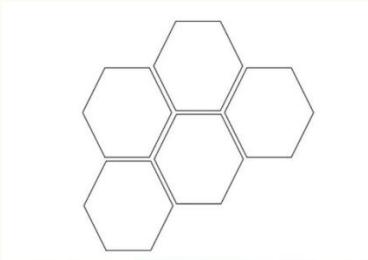
3. Radial-Circular Pattern

- Combination of radial roads connected by circular roads.
- Seen in planned cities like Chandigarh and Washington, D.C.
- Advantages: Better connectivity within different sectors.
- Disadvantages: Complex design requires careful planning.



4. Hexagonal Pattern

- Roads are arranged in a hexagonal grid.
- Found in modern city designs for better distribution of traffic.
- Advantages: Equal road spacing ensures efficient movement.
- Disadvantages: More intersections may require complex traffic signals.



5. Linear Pattern

- Roads develop along a single main route, often near railways or rivers.
- Suitable for mountainous or coastal regions.
- Advantages: Works well for towns along highways.
- Disadvantages: Limited connectivity between side areas.

8. Enumerate the salient features of third Road Development plan. ★

Also known as the Lucknow Plan, this strategy focused on integrating highway development with economic growth. Its key features include:

- 1. Road Density Target** – Planned 32 km of road per 100 sq. km to improve connectivity.
- 2. Rural Road Development** – Expanded village roads to ensure every village connects to nearby markets.
- 3. Expressway Network** – Introduced high-speed expressways for efficient long-distance travel.
- 4. Total Road Length Goal** – Proposed 1.5 million km of roads nationwide.
- 5. Classified Road System** – Divided roads into Primary (NH & SH) and Secondary (District & Rural Roads) categories.
- 6. Public Transport Enhancement** – Focused on bus and freight transport corridors for economic benefits.
- 7. Improved Maintenance & Upgradation** – Emphasized modern construction methods to extend road lifespan.

8. **Environmental Considerations** – Included policies for reducing pollution and conserving land near highways.
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9. Explain the Macadam method of road construction. ★

The Macadam method, developed by John Loudon McAdam in the early 19th century, revolutionized road construction by using compacted layers of broken stones to create durable and smooth road surfaces.

Key Features of the Macadam Method:

1. **Stone Base Layer** – Crushed stones (about 10 cm thick) are compacted to form a solid foundation.
 2. **Intermediate Layer** – Smaller stones (about 5 cm thick) are spread and compacted over the base.
 3. **Top Surface Layer** – Fine aggregates or sand mixed with water are laid and compacted to create a smooth surface.
 4. **Drainage System** – Slight camber (curvature) is provided to allow rainwater to drain off quickly.
 5. **Rolling & Compaction** – Heavy rollers compress the layers, creating a durable and well-bound road.
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10. Explain how the master plan is prepared and the road development programme is phased. ★

A Master Plan for road development is a long-term strategy that guides the expansion, improvement, and maintenance of road networks.

Steps in Preparing a Master Plan:

1. **Traffic & Population Study** – Analyzing current road usage and population growth trends.
2. **Identifying Key Transport Corridors** – Selecting major highways, bypasses, and city roads for development.
3. **Land Acquisition Planning** – Assessing land requirements for road expansion.

4. **Budget Estimation** – Determining costs and funding sources for construction.
5. **Environmental & Safety Considerations** – Studying impact on forests, rivers, and urban zones.
6. **Integration with Other Transport Systems** – Coordinating with rail, air, and metro networks for a holistic approach.

Phasing of Road Development Programme

1. Short-Term Plan (1–5 Years)

- Immediate improvements to existing roads (resurfacing, widening).
- Repairing damaged sections and constructing small bypasses.

2. Medium-Term Plan (5–10 Years)

- Building new highways and arterial roads to support economic growth.
- Expanding existing road capacity with flyovers, bridges, and interchanges.

3. Long-Term Plan (10–20 Years)

- Constructing expressways, tunnels, and advanced transportation projects.
- Implementing smart road technologies for better traffic management.

11. Briefly explain the Jayakar committee and its recommendations. ★

The Jayakar Committee was established in 1927 by the British government to assess the need for organized road development in India. It recognized the importance of highways for economic and social progress.

Key Recommendations:

1. **Road Development Fund** – Suggested a dedicated fund called the Central Road Fund (CRF), financed through taxes on fuel.

2. **National Highway System** – Proposed a structured highway network to connect major cities and ports.
 3. **Technical Training & Research** – Recommended specialized institutions for highway engineering, leading to the establishment of CRRI (Central Road Research Institute).
 4. **Road Classification** – Advocated dividing roads into different categories based on their function and importance.
 5. **Authority for Road Development** – Led to the formation of Indian Roads Congress (IRC) in 1934 to set standards for road construction.
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12. Enumerate salient features of road development plan vision 2021 ★

The Vision 2021 Road Development Plan aimed to create a modern, efficient, and sustainable road network in India. Its major highlights include:

1. **Expansion of Expressways** –
 - Promoted high-speed corridors to reduce travel time.
 - Example: Delhi–Mumbai and Delhi–Kolkata expressways.
2. **Rural Road Connectivity** –
 - Strengthened the Pradhan Mantri Gram Sadak Yojana (PMGSY) to improve village connectivity.
3. **Traffic Safety Measures** –
 - Introduced strict traffic regulations and road safety audits.
 - Emphasized construction of barriers and proper lighting.
4. **Environmental Sustainability** –
 - Focused on green roads, eco-friendly materials, and reduced emissions.
 - Encouraged tree plantations along highways.
5. **Use of Advanced Technology** –

- Integrated GIS mapping, automated toll collection, and smart traffic control systems.

6. Private Sector Participation –

- Boosted investments through Public-Private Partnerships (PPP) for better funding and efficiency.

UNIT 2: TRAFFIC ENGINEERING AND CONTROL

1. Explain in brief the importance and uses of Origin and Destination study.

The O-D study is a crucial traffic survey used to analyze how people and goods move between locations. It helps in planning and designing efficient transport systems.

Importance:

1. **Identifies Travel Patterns** – Helps understand where trips start and end.
2. **Improves Road Network Planning** – Assists in locating highways, bypasses, and transit routes.
3. **Traffic Management** – Optimizes signal timings, intersections, and congestion control.
4. **Public Transport Planning** – Determines the demand for buses, metro, or rail systems.
5. **Economic & Land Use Planning** – Guides future urban development based on travel needs.

Uses:

- Designing new roads or highways.
- Enhancing existing transportation infrastructure.
- Identifying congestion hotspots for mitigation.
- Estimating future traffic growth and planning expansions.

2. What is PCU? What are the factors on which PCU values depends?

PCU (Passenger Car Unit) is a unit used to compare different types of vehicles in terms of their impact on traffic flow. It represents how much space, speed, and maneuverability a vehicle occupies relative to a standard passenger car.

Factors Affecting PCU Values:

- 1. Vehicle Size & Speed** – Larger or slower vehicles (trucks, buses) have higher PCU values.
 - 2. Traffic Flow Conditions** – PCU changes in free-flow vs congested roads.
 - 3. Road Type & Width** – Wider roads allow better vehicle movement, reducing PCU impact.
 - 4. Intersection & Terrain** – Steep slopes or busy crossings may increase PCU values for heavy vehicles.
 - 5. Driving Behavior** – Aggressive driving or frequent lane changes affect PCU calculations.
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3. Define Highway capacity. Explain the terms basic capacity, possible capacity.

Highway capacity refers to the maximum number of vehicles a road can handle per hour under ideal conditions without causing congestion.

Types of Capacity:

1. Basic Capacity –

- The maximum possible traffic volume a road can carry per hour under ideal conditions (no obstructions, good weather, disciplined driving).
- Used as a theoretical benchmark for road design.

2. Possible Capacity –

- The actual maximum capacity considering real-world constraints like traffic rules, intersections, terrain, and environmental factors.
- Always lower than basic capacity due to disruptions like pedestrian crossings and vehicle mix.

Example:

- A 6-lane highway may have a basic capacity of 3000 vehicles per hour per lane, but due to signals, heavy vehicles, and turns, its possible capacity may be 2500 vehicles per hour per lane.
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4. Discuss in brief advantages and disadvantages of traffic signals

Traffic signals help regulate vehicle movement and improve road safety, but they come with both benefits and drawbacks.

Advantages:

- 1. Improves Safety** – Reduces accidents at intersections by controlling traffic flow.
- 2. Ensures Orderly Movement** – Organizes vehicle movement, especially during peak hours.
- 3. Facilitates Pedestrian Crossing** – Helps pedestrians cross safely in busy areas.
- 4. Controls Traffic Flow** – Minimizes congestion by alternating vehicle movement efficiently.
- 5. Reduces Conflict Points** – Prevents confusion between opposing flows of traffic.

Disadvantages:

- 1. Can Cause Delays** – Stops vehicles even when there's no conflicting traffic.
- 2. High Installation & Maintenance Cost** – Requires electrical power and regular servicing.
- 3. May Lead to Non-Compliance** – Some drivers may ignore signals, leading to violations.
- 4. Not Suitable for Low-Traffic Areas** – Unnecessary signals can create bottlenecks where simple signs would be enough.
- 5. Can Increase Rear-End Collisions** – Sudden stops at signals may lead to minor crashes.

5. What is understood by the following terms: ★

- i) **85th Percentile Speed :** The speed below which 85% of vehicles travel on a given road section under normal conditions.
 - Used to set speed limits for roads.
 - Helps in road safety planning.
 - ii) **A.A.D.T. (Annual Average Daily Traffic) :** The average number of vehicles per day passing a point over a year.
 - Helps in road capacity planning and traffic forecasting.
 - iii) **Space Mean Speed :** The average speed of all vehicles in a traffic stream, calculated based on distance and travel time.
 - Used in traffic flow analysis and congestion studies.
 - iv) **Parking Demand :** The total number of vehicles needing parking in an area at a given time.
 - Helps design parking facilities in cities, malls, or transport hubs.
 - v) **Grade Separated Interchange :** A road junction where traffic flows at different levels using bridges or tunnels to avoid conflicts.
 - Examples: Flyovers, underpasses, cloverleaf intersections.
 - Used on highways to improve safety and efficiency.
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6. What are the objective of carrying out spot speed studies?

Spot speed studies help analyze vehicle speeds at a specific location, providing essential data for road safety and traffic management.

Main Objectives:

1. **Traffic Control & Safety** – Determines speed limits and helps prevent accidents.

- 2. Road Design Improvements** – Assists in designing curves, intersections, and visibility zones.
 - 3. Signal Timing Optimization** – Helps adjust signal cycles for smoother traffic flow.
 - 4. Speed Variations Analysis** – Identifies slow-moving vehicles and fast drivers to manage mixed traffic conditions.
 - 5. Enforcement Planning** – Helps police monitor speeding violations effectively.
 - 6. Accident Prevention** – Detects locations where speed-related crashes are frequent and recommends safety measures.
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7. Write short notes on

- i) **Traffic Islands** : Traffic islands are raised or painted sections placed in roads to control movement, improve safety, and regulate traffic flow.

Types of Traffic Islands:

- Divisional Islands – Separates opposing lanes to prevent head-on collisions.
- Channelizing Islands – Guides vehicles into proper turning paths at intersections.
- Pedestrian Islands – Provides safe standing areas for pedestrians crossing roads.
- Refuge Islands – Found at intersections for pedestrian protection while waiting for a signal.

Traffic islands reduce conflicts between vehicles and pedestrians, making roads safer and more efficient.

- ii) **Rotary Intersections** : A rotary intersection (roundabout) is a circular junction where vehicles move counterclockwise around a central island, ensuring smooth and continuous traffic flow.

Features:

- Vehicles enter, circulate, and exit without stopping unless needed.
- Reduces conflict points, lowering accident risks compared to signalized crossings.
- Improves traffic efficiency, minimizing long wait times.
- Suitable for high-traffic areas where multiple roads meet.

Roundabouts reduce delays, fuel consumption, and emissions compared to signalized intersections.

8. What are the various vehicular characteristic affect the road design. ★

Several vehicle properties influence the design of roads, ensuring safety and efficiency.

- 1. Vehicle Size & Turning Radius** – Roads must accommodate large vehicles like trucks with proper turning space.
 - 2. Acceleration & Braking Ability** – Influences signal timing, stopping distances, and speed limits.
 - 3. Visibility & Headlight Range** – Determines Road marking, curves, and intersection safety.
 - 4. Axle Load & Weight** – Heavy vehicles impact pavement thickness and bridge design.
 - 5. Speed Variation** – Mixed traffic speeds affect lane width, merging lanes, and overtaking zones.
 - 6. Lane Occupancy** – Wider vehicles require larger lanes, while motorcycles can use narrow spaces efficiently.
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9. What are the objectives of carrying accident studies? How are the results of this study used?

Objectives of Accident Studies

- 1. Identify High-Risk Locations** – Helps pinpoint accident-prone areas.
- 2. Analyze Causes** – Determines if crashes result from speeding, road defects, or driver behavior.

- 3. Improve Road Safety Design** – Guides improvements in signage, signals, road markings, and speed limits.
- 4. Assist Law Enforcement** – Helps in stricter speed control, traffic rules enforcement, and driver education.
- 5. Enhance Emergency Response** – Helps reduce accident severity with better medical and rescue services.

Uses of Accident Study Results

- **Policy Making** – Governments set safety regulations based on accident data.
 - **Engineering Measures** – Redesign of road curves, intersections, barriers, and pedestrian crossings.
 - **Awareness Campaigns** – Educates drivers on accident risks to prevent reckless driving.
 - **Insurance & Cost Analysis** – Helps estimate economic losses due to accidents.
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10. What are the objectives of carrying out traffic volume study?

A traffic volume study measures the number of vehicles passing a point to help in road planning and safety management.

Key Objectives:

- 1. Highway Capacity Analysis** – Determines how many vehicles a road can handle efficiently.
- 2. Identifying Peak Traffic Hours** – Helps in adjusting signal timing and designing bypasses.
- 3. Road Expansion Planning** – Provides data to decide if widening lanes or adding flyovers is needed.
- 4. Traffic Management Strategies** – Supports decisions on one-way streets, speed limits, and public transport routes.
- 5. Economic & Infrastructure Development** – Assists in planning commercial areas, parking spaces, and fuel stations.

11. Discuss the various causes of accident and mention the measures to reduce accident rate.

Causes of Road Accidents:

1. Over-Speeding – Reduces reaction time and increases crash severity.
2. Distracted Driving – Using mobile phones or eating while driving leads to loss of focus.
3. Drunk Driving – Alcohol impairs judgment and reflexes.
4. Poor Road Conditions – Potholes, sharp curves, and inadequate signage contribute to accidents.
5. Faulty Vehicles – Brake failures or tire bursts result in dangerous situations.
6. Lack of Traffic Discipline – Violating signals, improper lane changes, and reckless driving increase risks.
7. Pedestrian Negligence – Ignoring crosswalks or jaywalking leads to collisions.
8. Weather Conditions – Fog, rain, and slippery roads reduce visibility and control.

Measures to Reduce Accident Rates:

1. Speed Limit Enforcement – Installing speed cameras and stricter fines.
2. Improved Road Design – Providing proper markings, signals, and rumble strips.
3. Vehicle Safety Checks – Ensuring regular inspections for buses and trucks.
4. Traffic Education – Public awareness campaigns for responsible driving.
5. Pedestrian Facilities – Footbridges, zebra crossings, and sidewalks enhance safety.
6. Drunk Driving Laws – Stricter legal consequences for intoxicated drivers.
7. Better Emergency Response – Quicker ambulance services and accident management teams.

8. Weather-Adaptive Infrastructure – Anti-skid surfaces and proper drainage prevent accidents in rain-prone areas.
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12. With neat sketches, explain any five traffic regulatory signs.

Traffic regulatory signs are mandatory signs that guide drivers and ensure road discipline. Here are five important regulatory signs:

1. Stop Sign

- Meaning: Drivers must stop before proceeding.
- Usage: At intersections, railway crossings, and high-risk areas.
-  STOP

2. No Entry Sign

- Meaning: Vehicles cannot enter beyond this point.
- Usage: One-way streets, restricted zones, and private roads.
-  NO ENTRY

3. Speed Limit Sign

- Meaning: Vehicles must not exceed the specified speed.
- Usage: Highways, school zones, city roads.
-  SPEED LIMIT 50

4. One-Way Sign

- Meaning: Vehicles must move only in the indicated direction.
- Usage: Roads with controlled traffic flow.
-  ONE WAY

5. No Parking Sign

- Meaning: Vehicles cannot park in the designated zone.
 - Usage: Near hospitals, government offices, and narrow roads.
 -  NO PARKING
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13. Write short notes on

i) Parking Studies

Parking studies analyze the demand, availability, and usage of parking spaces to improve urban planning and traffic management.

Objectives:

- Identify parking congestion areas.
- Plan sufficient parking spaces in cities, malls, and transport hubs.
- Reduce illegal parking and improve traffic flow.

Types of Parking:

- On-street Parking – Vehicles Park alongside roads, affecting traffic flow.
- Off-street Parking – Dedicated parking lots or garages for organized space.

ii) Highway Lighting

Highway lighting enhances visibility, safety, and road efficiency, especially at night.

Importance:

- Prevents accidents in low-visibility conditions.
- Helps pedestrians and cyclists see roads clearly.
- Improves driver alertness and reduces fatigue.

Types of Highway Lighting:

- Conventional Street Lights – Tall poles with overhead lighting.
- Solar-Powered Lights – Energy-efficient and eco-friendly solutions.
- Reflective Road Markings – Helps in low-light driving conditions.