GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–I & II PAPER SOLUTION – WINTER 2024

Subject Code:3110004

Subject Name: Basic Civil Engineering

Q.1 **(a)** Enlist different branches of civil engineering and explain any two. **03**

Answer:

The main branches of Civil Engineering are:

1. Structural Engineering
2. Transportation Engineering
3. Geotechnical Engineering
4. Environmental Engineering
5. Water Resources Engineering
6. Construction Engineering and Management
7. Surveying
8. Town Planning

1. Structural Engineering:

This branch deals with the design and analysis of structures like buildings, bridges, dams, and towers. It ensures that the structures can safely withstand loads such as dead load, live load, wind load, and seismic forces.

2. Transportation Engineering:

It focuses on the planning, design, and maintenance of transportation systems such as roads, railways, airports, and highways. The aim is to provide safe, efficient, and sustainable movement of people and goods.

(b) Discuss properties of cement. **04**

Answer:

Cement is a key construction material and its properties significantly affect the strength and durability of structures. The important properties of cement are as follows:

1. **Fineness**:
    - Fineness refers to the particle size of cement.
    - Finer cement has a greater surface area and hence, it gains strength quickly due to faster hydration.
2. **Setting Time**:
    - Setting time is the time required for cement to change from a plastic state to a hardened state.
    - It is divided into:
        - **Initial Setting Time** (minimum 30 minutes)

- **Final Setting Time** (maximum 10 hours)

3. **Soundness**:
   - Soundness refers to the ability of cement to retain its volume after setting.
   - Unsound cement may expand and crack after setting, which is undesirable.
   - It is tested using the Le Chatelier apparatus.
4. **Strength**:
   - The compressive strength of cement is crucial for construction work.
   - It is usually tested after 3, 7, and 28 days of curing.
   - Ordinary Portland Cement (OPC) should have a minimum 28-day strength of 33 N/mm², 43 N/mm², or 53 N/mm² based on grade.
5. **Consistency**:
   - This is the amount of water required to make a cement paste of standard viscosity.
   - Standard consistency is about 25–30% of water by weight of cement.
6. **Heat of Hydration**:
   - Heat is released when cement reacts with water.
   - It is important to control this heat in mass concrete works like dams.

(c) What are the key components of GIS? Describe them briefly. **07**

Answer:

GIS (Geographic Information System) is a computer-based tool used to capture, store, analyze, manage, and display spatial or geographical data. It helps in decision-making related to land use, infrastructure planning, resource management, and environmental studies.
The key components of GIS are:

1. **Hardware:**
   Hardware refers to the physical components of the computer system on which GIS software operates. This includes high-performance computers, servers, monitors, printers, plotters, GPS devices, and scanners used for data collection, analysis, and output.
2. **Software:**
   GIS software provides the tools and functions required to store, analyze, and visualize spatial data. Examples of GIS software include ArcGIS, QGIS, and GRASS GIS. These programs support data entry, editing, query, analysis, and map generation.
3. **Data:**
   Data is the core of any GIS. It is categorized into two types:
   - **Spatial Data:** Refers to the geographical representation of features such as roads, rivers, buildings, etc.
   - **Attribute Data:** Provides descriptive information about spatial

features, such as the name of a road, population of a city, or height of a mountain.

4. **People:**
   Skilled personnel such as GIS analysts, surveyors, engineers, and planners who collect, analyze, and interpret data are essential to a GIS. Their expertise ensures the effective use and management of the system.
5. **Methods (or Procedures):**
   These are the techniques, models, and guidelines followed for data collection, processing, analysis, and presentation. Standardized procedures ensure accuracy, consistency, and reliability of results in GIS applications.

Q.2 **(a)** Convert the following WCB in to RB: 1) 55°30’ 2) 279°00’ 3) 190°00' **03**

Answer:

To convert Whole Circle Bearing (WCB) into Reduced Bearing (RB), we follow the quadrant system:

- **0° to 90° → NE** → RB = WCB
- **90° to 180° → SE** → RB = (180° – WCB)
- **180° to 270° → SW** → RB = (WCB – 180°)
- **270° to 360° → NW** → RB = (360° – WCB)

Now, apply these rules:

1. **WCB = 55°30’**
   → Lies between 0° and 90°
   → **RB = N 55°30’ E**
2. **WCB = 279°00’**
   → Lies between 270° and 360°
   → RB = 360° – 279°00’ = **81°00’**
   → **RB = N 81°00’ W**
3. **WCB = 190°00’**
   → Lies between 180° and 270°
   → RB = 190°00’ – 180° = **10°00’**
   → **RB = S 10°00’ W**

Final Answers:

1. N 55°30’ E
2. N 81°00’ W
3. S 10°00’ W

(b) Explain primary division of surveying. **04**

Answer:

The primary division of surveying is based on the **nature of the surface being surveyed** and the **extent of the area**. It is mainly divided into two types:

1. Plane Surveying:

- In plane surveying, the earth's surface is considered **flat** or **plane**.
- It is suitable for **small areas** (typically less than 250 sq. km).
- The **curvature of the earth** is neglected.
- Angles and distances are measured on a horizontal plane.
- It is commonly used for engineering projects like roads, buildings, and canals.

2. Geodetic Surveying:

- In geodetic surveying, the **curvature of the earth** is taken into account.
- It is used for **large areas** (more than 250 sq. km).
- Highly precise instruments and methods are used.
- It is mainly conducted by government agencies like the **Survey of India**.

(c) Discuss classification of buildings based on structure. **07**

Answer:

Buildings can be classified on various bases, and one of the most important classifications is based on **structural system**. The classification based on structure is mainly as follows:

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1. Load Bearing Structure:

In this type of construction, the **walls** of the building carry the **entire load** of the structure including the roof and floors. The walls transfer the load directly to the foundation.

- **Materials Used:** Brick, stone, or concrete blocks
- **Features:**
  - Simple in construction
  - Suitable for low-rise buildings (usually up to 2–3 storeys)
  - Thick walls are required to bear load
- **Example:** Traditional houses, village homes

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2. Framed Structure:

In a framed structure, the **load is carried by beams and columns**, not by the walls. The walls act only as partitions and do not carry any structural load.

- **Materials Used:** Reinforced Cement Concrete (RCC) or steel
- **Features:**
  - Suitable for multi-storey buildings
  - Offers flexibility in planning and space utilization
  - Lightweight partition walls can be used
- **Example:** Office buildings, shopping malls, high-rise apartments

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3. Composite Structure:

Composite structures are built using a **combination of load-bearing walls and framed structural elements**. Part of the structure may carry the load through walls, while the remaining load is supported by beams and columns.

- **Materials Used:** A mix of brick masonry and RCC/steel
- **Features:**
  - Economical for medium-rise buildings
  - Combines benefits of both types
- **Example:** Educational institutions, mid-rise residential buildings

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Conclusion:
Classification of buildings based on structure is essential for selecting the appropriate construction technique based on the building's height, purpose, cost, and site conditions. The three main structural types—**load-bearing**, **framed**, and **composite**—each have their own merits and are selected according to specific project needs.

OR

(c) Write short note on HVAC. **07**

Answer:

HVAC stands for **Heating, Ventilation, and Air Conditioning**. It refers to the various systems used for **moving air between indoor and outdoor areas**, along with **heating and cooling** both residential and commercial buildings.
HVAC systems are important for **maintaining indoor environmental comfort**. The main purpose is to provide **thermal comfort** and **acceptable indoor air quality (IAQ)**.

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1. Heating:
- Provides warmth in cold weather.
- Common heating systems include:
  - Boilers
  - Furnaces
  - Electric heaters
- Heat can be distributed using hot water (hydronic systems), steam, or warm air through ducts.

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2. Ventilation:
- Ventilation is the process of **exchanging or replacing air** within a space.
- It removes:
  - Moisture
  - Odours
  - Smoke
  - Heat
  - Dust
  - Carbon dioxide
- Ventilation can be:
  - **Natural**: Through windows, doors, and vents
  - **Mechanical**: Using fans and exhaust systems

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3. Air Conditioning (Cooling):
- Maintains desired **cool temperature** in hot climates.
- Removes **excess heat and humidity** from indoor spaces.

- Works using refrigerants and compressors.
- Centralized or split AC systems are commonly used.

Applications of HVAC in Civil Engineering:

- Design of **residential buildings**, **offices**, **hospitals**, **airports**, and **industrial buildings**.
- Ensures **energy efficiency**, **comfort**, and **health safety** in buildings.
- HVAC planning is part of **building services design** in modern construction projects.

Conclusion:
HVAC systems are essential for creating **safe, healthy, and comfortable living and working environments**. In civil engineering, proper design and installation of HVAC systems is a critical part of **building services** and modern infrastructure development.

Q.3 **(a)** Discuss aims and objectives of town planning. **03**

Answer:

The main **aims and objectives of town planning** are as follows:

1. **Proper Use of Land:**
   To ensure balanced use of land for residential, commercial, industrial, and recreational purposes.
2. **Healthy Living Environment:**
   To provide hygienic, safe, and comfortable living conditions by controlling overcrowding and ensuring good ventilation and sanitation.
3. **Efficient Transportation:**
   To develop an efficient road network and public transport system for easy and safe movement of people and goods.
4. **Public Amenities and Services:**
   To provide essential services like water supply, drainage, electricity, education, healthcare, and recreation.
5. **Future Growth Accommodation:**
   To plan in advance for population growth, economic development, and future infrastructure needs.
6. **Beautification and Aesthetics:**
   To enhance the physical appearance of the town through landscaping, open spaces, and architectural control.

(b) Describe pillars of smart city. **04**

Answer:

A **Smart City** uses digital technologies to enhance performance, well-being, and reduce costs and resource consumption across the city. The key **pillars of a Smart City** are:

1. Smart Governance:
- Transparent and efficient administration using technology.
- Citizen participation and online services (e-Governance).

2. Smart Economy:
- Promotes innovation, entrepreneurship, and sustainable growth.
- Focus on digital transactions and business ease.

3. Smart Mobility:
- Efficient public transport systems and reduced traffic congestion.
- Use of Intelligent Traffic Management and eco-friendly vehicles.

4. Smart Environment:
- Focus on sustainability, green energy, waste management, and pollution control.
- Conservation of resources like water and electricity.

5. Smart People:
- Educated, skilled, and socially aware citizens.
- Digital literacy and community participation.

6. Smart Living:
- High quality of life with access to healthcare, education, safety, and housing.
- Use of smart health and education services.

(c) Describe the important remedial measures to prevent slum formation. **07**

Answer:

Slums are overcrowded, poorly built, and unhygienic settlements usually found in urban areas. They arise due to rapid urbanization, poverty, lack of housing, and poor planning. The prevention of slum formation is essential for maintaining public health, urban aesthetics, and sustainable development. The important **remedial measures** to prevent slum formation are as follows:

1. Affordable Housing:
- Government and private agencies should construct **low-cost housing schemes** for economically weaker sections (EWS).
- Housing policies must encourage **mass housing projects** with basic amenities.

2. Proper Urban Planning:
- Town planning authorities should ensure **planned development** of cities with adequate space for housing, sanitation, roads, and public services.
- Future population growth should be considered while designing infrastructure.

3. Employment Opportunities in Rural Areas:
- Migration to cities is a major cause of slum formation.
- **Rural development programs** should be promoted to provide **local employment** and reduce urban migration.

4. Provision of Basic Services:

- Existing poor settlements should be provided with **water supply, drainage, sanitation, electricity**, and waste management to improve living conditions.
- Slum upgradation is a better option than eviction.

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5. Strict Control on Encroachments:

- Illegal occupation of land should be **strictly controlled** by urban authorities.
- Regular monitoring and **strict enforcement of building and land-use regulations** is necessary.

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6. Public Awareness and Participation:

- Citizens should be made aware of the **ill-effects of slums** through education and media.
- **Community participation** in housing and cleanliness projects should be encouraged.

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7. Government Schemes and Policies:

- Implementation of schemes like **PMAY (Pradhan Mantri Awas Yojana)**, **JNNURM**, and **Smart City Mission** to support urban housing and slum rehabilitation.
- Financial and technical support should be extended to slum dwellers for construction of safe homes.

Conclusion:

Slum formation is a **serious social and environmental issue**. With **planned development**, **affordable housing**, and **strong policy implementation**, slum growth can be effectively controlled. Preventing slums not only improves quality of life but also contributes to a **cleaner, safer, and healthier urban environment**.

OR

Q.3 **(a)** Discuss traffic characteristics. **03**

Answer:

The main **traffic characteristics** are categorized into three types:

1. **Road User Characteristics:**
   These include physical, mental, and psychological traits of road users such as vision, hearing, reaction time, judgment, and driving habits. These factors affect the safety and efficiency of traffic flow.
2. **Vehicular Characteristics:**
   These refer to the size, weight, speed, braking capacity, and maneuverability of vehicles. Different types of vehicles (e.g., bicycles, cars, buses, trucks) influence road design and capacity.
3. **Traffic Flow Characteristics:**
   These include volume (number of vehicles per hour), speed (average, spot, and design speed), and density (vehicles per kilometer). These are essential for designing and managing roadways and intersections.

(b) Explain site plan and key plan. **04**

Answer:

1. Site Plan:

- A **site plan** is a detailed drawing that shows the proposed development on a specific plot of land.
- It includes:
  - Boundaries and dimensions of the plot.
  - Location of buildings, roads, and other structures.
  - Setbacks, open spaces, and landscaping.
  - Drainage, water supply, and sewer lines.
- It is **drawn to a larger scale** (e.g., 1:200 or 1:500).
- Used by architects, engineers, and municipal authorities for approval and construction.

2. Key Plan:

- A **key plan** is a small-scale drawing that shows the **location of the site with respect to surrounding landmarks**.
- It helps to identify the site's position in a broader area.
- It includes:
  - Roads, nearby towns or cities.
  - Important landmarks like railway stations, rivers, etc.
- It is **drawn to a smaller scale** (e.g., 1:10,000 or 1:50,000).
- Mainly used for location reference in official documents and project reports.

(c) Enumerate various principles of planning and explain any two in detail. **07**

Answer:

Principles of Planning refer to the basic guidelines that must be followed while designing and constructing residential or public buildings to ensure proper use of land, safety, comfort, and economy.

The major principles of planning are:

1. **Aspect**
2. **Prospect**
3. **Privacy**
4. **Grouping**
5. **Roominess**
6. **Furniture Requirements**
7. **Sanitation**
8. **Flexibility**
9. **Elegance**
10. **Economy**
11. **Circulation**

Explanation of Any Two Principles:

1. Aspect:

- Aspect refers to the **orientation of a building or room** to receive **maximum natural light, air, and ventilation**.
- Rooms are placed according to the direction of sunlight:
  - **Living rooms and bedrooms** are usually placed facing east to receive morning sunlight.

- **Kitchens** are often located in the southeast.
- A well-aspected plan improves **health and comfort** of the occupants.

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2. Privacy:

- Privacy is the **separation of spaces** to avoid unwanted visibility and noise between rooms or from outside.
- For example:
  - Bedrooms and bathrooms should be located away from the living or guest area.
  - The main entrance should not open directly into a private room.
- Proper privacy ensures **comfort, safety, and dignity** of users.

Conclusion:
Following proper **principles of planning** ensures that the building is **functional, economical, comfortable, and aesthetically pleasing**. These principles form the foundation of **efficient architectural and civil design**.

Q.4 **(a)** What are the various types of loads acting on building. **03**

Answer:

The different types of loads acting on a building are:

1. **Dead Load:**
   These are permanent loads due to the self-weight of structural components such as walls, floors, roofs, beams, and columns.
2. **Live Load:**
   These are temporary or movable loads caused by occupants, furniture, equipment, and other movable objects. Live loads vary with usage.
3. **Wind Load:**
   The pressure exerted by wind on the structure. It depends on wind speed, height, and exposure of the building.
4. **Snow Load:**
   The load due to accumulation of snow on roofs, applicable in cold regions.
5. **Seismic Load (Earthquake Load):**
   Forces induced in a structure due to ground motion during an earthquake.
6. **Other Loads:**
   These may include thermal loads, impact loads, and settlement loads depending on the design conditions.

(b) Discuss importance of zoning. **04**

Answer:
Zoning is the process of dividing land in a municipality or city into zones

where certain land uses are permitted or prohibited. It plays a crucial role in urban planning.

Importance of Zoning:

1. **Proper Land Utilization:**
   - Zoning ensures systematic development by allocating land for residential, commercial, industrial, and recreational purposes.
2. **Prevents Land Use Conflicts:**
   - It avoids mixing of incompatible land uses, such as placing industries near residential areas, thus reducing pollution and health hazards.
3. **Improves Quality of Life:**
   - Helps in providing a clean, safe, and organized environment by separating noisy or hazardous areas from living spaces.
4. **Guides Infrastructure Development:**
   - Assists in planning roads, drainage, water supply, and other services efficiently according to land use.
5. **Controls Density and Congestion:**
   - Limits the number and size of buildings in a zone, reducing overcrowding and traffic problems.
6. **Supports Future Growth:**
   - Ensures sustainable development by preserving open spaces and planning for future expansion.

(c) Discuss rooftop rain water harvesting system with neat sketch. **07**

Answer:

Rainwater Harvesting is the technique of collecting and storing rainwater for reuse, rather than allowing it to run off. **Rooftop rainwater harvesting** involves collecting rainwater from the roof surface and directing it to a storage tank or into the ground to recharge groundwater.

Components of Rooftop Rainwater Harvesting System:

1. **Catchment Area:**
   - The rooftop surface where rain falls.
   - It should be clean, sloped, and made of non-toxic material.
2. **Gutters and Downpipes:**
   - Gutters are fixed along the edges of the roof to collect rainwater.
   - Downpipes carry the water from gutters to the collection system.
3. **Filter Unit:**
   - Removes leaves, debris, dust, and other impurities from collected water.
   - Common filters include sand filters, charcoal filters, and mesh screens.
4. **Storage Tank or Recharge Pit:**
   - Treated water is either stored in tanks for domestic use or directed to a recharge pit to improve groundwater levels.
5. **First Flush System:**
   - The initial dirty water from the first rain is flushed out to avoid contamination of the storage tank.

Advantages of Rooftop Rainwater Harvesting:

- Reduces dependency on groundwater.
- Increases groundwater table through recharge.
- Prevents urban flooding.
- Saves water bills in residential buildings.
- Environmentally friendly and sustainable.

OR

Q.4 **(a)** Enlist the various instruments used in chaining. **03**

Answer:

The various instruments used in chaining are:

1. **Chain** – Used for measuring distances on the ground.
2. **Arrows** – Used for marking the end of a chain length on the ground.
3. **Ranging Rods** – Used to mark and align the survey line between two points.
4. **Pegs** – Wooden or iron stakes used to mark station points on the ground.
5. **Plumb Bob** – Used for transferring points to the ground in case of elevated survey stations.
6. **Cross Staff** – Used for setting out right angles during surveying.
7. **Tape** – Sometimes used as a supplementary tool for accurate short measurements.

(b) Differentiate between prismatic compass and surveyor compass. **04**

Answer:

Point of Difference	Prismatic Compass	Surveyor's Compass
1. Type of Reading	Gives **Whole Circle Bearing (WCB)**	Gives **Reduced Bearing (RB)**
2. Graduation on Ring	Graduated from **0° to 360°** in clockwise direction	Graduated from **0° to 90°** in each quadrant
3. Line of Sight	Has a **sighting slit with prism** for direct reading	Has a **sighting vane** and **object vane**
4. Position of Reading	Reading is taken **through a prism** while sighting	Reading is taken **after sighting**, not simultaneously
5. Use	More accurate and commonly used in modern surveying	Mostly used in traditional surveying work

(c) Discuss the general features of earthquake resistant buildings. **07**

Answer:

An **earthquake-resistant building** is designed to withstand the forces and vibrations generated during an earthquake without collapsing or suffering major structural damage. The aim is to ensure the **safety of occupants** and **minimize structural loss**.
The general features of earthquake-resistant buildings are:

1. Light Weight Structure:

- Buildings should have **less mass** to reduce earthquake-induced forces.
- Use of **lightweight construction materials** for non-structural elements like partitions and roofs is preferred.

2. Symmetrical Plan:

- Buildings should have a **simple, regular, and symmetrical plan**.
- Irregular shapes cause **torsional (twisting) effects**, which are dangerous during earthquakes.

3. Strong Foundation:

- The foundation must be laid on **firm ground**.
- In case of weak soil, proper soil improvement techniques or deep foundations should be adopted.

4. Reinforced Concrete Frames:

- Use of **RCC frames with strong columns and beams** provides strength and flexibility.
- Proper detailing and **ductility (flexibility)** of joints is essential to absorb seismic energy.

5. Shear Walls and Bracing:

- **Shear walls** are vertical walls designed to resist lateral forces.
- **Cross bracing** using steel members helps in increasing lateral stability.

6. Separation Joints:

- Large buildings should be separated into smaller units using **expansion/separation joints**.
- This prevents collision of different parts during shaking (pounding effect).

7. Use of Earthquake-Resistant Materials:

- Use of **high-quality concrete, steel, and flexible joints** to withstand seismic forces.
- Avoid brittle materials in primary structural members.

8. Proper Roof and Parapet Design:

- Heavy projections, overhangs, parapet walls, and unsupported elements should be **avoided or properly anchored**.
- Roofs should be firmly connected to the walls.

9. Quality Construction and Workmanship:

- Strict adherence to **IS Codes** and **design standards**.
- Proper **supervision**, **mixing**, **curing**, and **execution** ensure safety and durability.

Conclusion:

Earthquake-resistant buildings are essential in seismically active regions to protect **life and property**. By incorporating the above features in design and construction, civil engineers can ensure **stability, safety, and resilience** of structures during earthquakes.

Q.5 **(a)** What are the different types of meridians? **03**

Answer:

The different types of meridians used in surveying are:

1. **True Meridian:**
   The line on the earth's surface that passes through the geographic North and South Poles. It remains constant for a given location and is determined by astronomical observations.
2. **Magnetic Meridian:**
   The direction indicated by a freely suspended magnetic needle, which aligns itself with the Earth's magnetic field. It varies from place to place and changes over time.
3. **Grid Meridian:**
   The meridian lines shown on a map grid system. These are parallel to the central meridian of the map projection used.
4. **Arbitrary Meridian:**
   Any convenient direction assumed as a reference line for a local survey, usually chosen for simplicity when true or magnetic meridian is not required.

(b) Explain the working principle of Line ranger. **04**

Answer:

Line Ranger – Working Principle:
A **Line Ranger** is a simple optical instrument used in surveying to **locate intermediate points** on a straight line between two end stations.
Construction:

- It consists of **two right-angled isosceles prisms** mounted together in a cylindrical metal frame.
- Each prism has a **mirror surface** that reflects light at **90°**, allowing the observer to see two different objects at once.

Working Principle:

- The instrument works based on the **principle of reflection**.
- When the observer looks through the Line Ranger, he sees the images of both end stations (say A and B) simultaneously.
- The observer moves sideways until both reflected images appear to be in a **straight line**.
- At that point, the instrument is exactly on the line joining points A and B, and the **ground position directly below the instrument** is an intermediate point on the line.

Use:

- Line Ranger is commonly used in chain surveying for setting out points in between two survey stations accurately and quickly.

(c) The following are bearings of a closed traverse ABCDA. Find out interior angles and correct them if necessary. **07**

LINE	FB	B.B
AB	**45°00'**	**225°00'**
BC	**123°30'**	**303°30'**
	181°00'	
DA	**289°00'**	**109°00'**

Answer:

Step 1: Interior Angle Formula
Interior angle at a station =
(B.B. of incoming line – F.B. of outgoing line)
→ If result is negative, add 360°.

Step 2: Calculate Interior Angles
At Station B:
= B.B. of AB − F.B. of BC
= 225°00′ − 123°30′ = **101°30′**

At Station C:
= B.B. of BC − F.B. of CD
= 303°30′ − 181°00′ = **122°30′**

At Station D:
= B.B. of CD − F.B. of DA
= 1°00′ − 289°00′ = **–288°00′**
→ Add 360° → **72°00′**

At Station A:
= B.B. of DA − F.B. of AB
= 109°00′ − 45°00′ = **64°00′**

Step 3: Sum of Interior Angles (Check for Correction)
For a **closed quadrilateral traverse**,
Sum of interior angles = (n − 2) × 180° = (4 − 2) × 180° = **360°**
Add calculated angles:
= 64°00′ + 101°30′ + 122°30′ + 72°00′
= **360°00′** ✅

Conclusion:
- All interior angles are correctly calculated.
- Since the **total = 360°**, **no correction is needed**.

Final Interior Angles:

Station	Interior Angle

A 64°00′
B 101°30′
C 122°30′
D 72°00′

OR

Q.5 **(a)** What are the uses of contour map? **03**

Answer:

The main uses of a contour map are:

1. **Determining Slope and Elevation:**
   Contour maps help in understanding the nature of the ground surface, such as steepness or flatness, by showing elevation through contour lines.
2. **Planning of Engineering Projects:**
   They are used in the planning and design of roads, railways, canals, dams, and reservoirs by helping engineers select the best alignment with minimum earthwork.
3. **Estimating Earthwork:**
   Contours assist in calculating the volume of cutting and filling required for construction purposes.
4. **Locating Catchment Areas:**
   Useful in hydrology to identify drainage patterns, watershed boundaries, and flow directions of rivers and streams.
5. **Site Selection:**
   Helps in selecting suitable sites for buildings and other structures by analyzing land profiles.
6. **Military and Defense Uses:**
   Contour maps are used for strategic planning of troop movement and positioning.

(b) Describe various types of benchmarks. **04**

Answer:

A **benchmark** is a fixed reference point of known elevation used in surveying to determine the elevation of other points.

Types of Benchmarks:

1. **G.T.S. Benchmark (Great Trigonometrical Survey Benchmark):**
   - Established by the **Survey of India**.
   - Very accurate and based on long-term geodetic surveys.
   - Used as a **primary reference** in large-scale surveys.
   - Their values are published in official records.
2. **Permanent Benchmark:**
   - Fixed by government departments such as PWD or municipal bodies.
   - Marked on **permanent structures** like culverts, walls, or buildings.
   - Used for **local surveys** and remain unchanged over time.
3. **Arbitrary Benchmark:**
   - Used for small-scale or temporary surveys.
   - An **assumed elevation** (e.g., 100.00 m) is given to a point, usually on-site.
   - Not suitable for long-term use or comparison between projects.

4. **Temporary Benchmark:**
    - Established at the end of a day's work or for short-term use.
    - Located on objects like stones, tree bases, or pegs.
    - Used for transferring levels from one day's work to the next.

(c) The following observations were taken with dumpy level and four-meter levelling staff. The instrument was shifted after 4^{th} and 7^{th} readings. The first reading was taken on a B.M whose RL is 15.575m, prepare a page of level book and calculate RLs of all the points. The observation was taken at every 30m interval. Also find the gradient between first and last point. The observations are:0.565, 1.250, 1.675, 3.695, 0.125, 2.345, 3.245, 0.500, 1.785, 2.535. **07**

Answer:

Given Data:

- **Readings (in order):** 0.565, 1.250, 1.675, 3.695, 0.125, 2.345, 3.245, 0.500, 1.785, 2.535
- **B.M. RL (Benchmark):** 15.575 m
- **Instrument shifted after 4th and 7th readings**
- **Observation interval:** 30 meters

****Step 1: Arrange the data in a Level Book Format using the Height of Instrument (HI) Method**

Sr. No.	B.S.	I.S.	F.S.	HI	RL	Remarks
1	0.565			16.140	15.575	B.M.
2		1.250			14.890	
3		1.675			14.465	
4			3.695		12.445	F.S. (Inst. shifted)
5	0.125			12.570	12.445	New Inst. Position
6		2.345			10.225	
7			3.245		9.325	F.S. (Inst. shifted)
8	0.500			9.825	9.325	New Inst. Position
9		1.785			8.040	
10			2.535		7.290	Last Point

Step 2: Explanation of Calculations

- **HI = RL + B.S.**
- **RL = HI - I.S. or F.S.**

Step 3: Gradient Calculation

- **Distance between first and last point** = 9 intervals × 30 m = **270 m**
- **First RL (B.M)** = 15.575 m
- **Last RL** = 7.290 m
- **Difference in level = 15.575 – 7.290 = 8.285 m**

$$\text{Gradient} = \frac{\text{Vertical Difference}}{\text{Horizontal Distance}} = \frac{8.285}{270} = 1 \text{ in } 32.6$$

Final Answer Summary:

- **RL of last point = 7.290 m**
- **Gradient = 1 in 32.6 (fall)**

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