Course File On

SURVEYING AND GEOMATICS

By

P MAHANTESH

Assistant Professor

Civil Engineering Department

K. G. Reddy College of Engineering and Technology

2019-2020

HOD

PRINCIPAL
<table>
<thead>
<tr>
<th><strong>Subject (Name)</strong></th>
<th>SURVEYING AND GEOMATICS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong> (of the Faculty Member)</td>
<td>P.MAHANTESH</td>
</tr>
<tr>
<td><strong>Designation</strong></td>
<td>Asst. Prof.</td>
</tr>
<tr>
<td><strong>Regulation /Course Code</strong></td>
<td>R 18/ CE301PC</td>
</tr>
<tr>
<td><strong>Year / Semester</strong></td>
<td>II&lt;sup&gt;nd&lt;/sup&gt; / I&lt;sup&gt;st&lt;/sup&gt;</td>
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<tr>
<td><strong>Department</strong></td>
<td>Civil Engineering</td>
</tr>
<tr>
<td><strong>Academic Year</strong></td>
<td>2019-20</td>
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<td>g). Assessment Methodologies-Direct</td>
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<td></td>
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<td></td>
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<td></td>
<td>3 Five marks question with answers</td>
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</tr>
<tr>
<td></td>
<td>4 Objective question with answers</td>
<td>10 questions</td>
</tr>
<tr>
<td></td>
<td>5 Fill in the blanks question with answers</td>
<td>10 questions</td>
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<tr>
<td>17</td>
<td>Beyond syllabus Topics with material</td>
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</tr>
<tr>
<td>18</td>
<td>Result Analysis-Remedial/Corrective Action</td>
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<tr>
<td>19</td>
<td>Record of Tutorial Classes</td>
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<td>20</td>
<td>Record of Remedial Classes</td>
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PART-2

<table>
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<td>Time Table</td>
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<td>Academic Calendar</td>
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<td>Continuous Evaluation-marks (Test, Assignments etc)</td>
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<td>Status Request internal Exams and Syllabus coverage</td>
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<td>Teaching Diary/Daily Delivery Record</td>
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<td>Continuous Evaluation – MID marks</td>
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<td>8</td>
<td>Assignment Evaluation- marks /Grades</td>
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<tr>
<td>9</td>
<td>Special Descriptive Tests Marks</td>
</tr>
<tr>
<td>10</td>
<td>Sample students descriptive answer sheets</td>
</tr>
<tr>
<td>11</td>
<td>Sample students assignment sheets</td>
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</tbody>
</table>

1. A) Vision of Civil Engineering Department

To give the world new age civil engineers who can transform the society with their creative vibe for the sustainable development by instilling scientific temper with ethical human outlook.

B) Mission of Civil Engineering Department

1. To become pioneers in technical education and serve the community, government in the form of consultancy and research activities.
2. To impart quality education with application oriented teaching methodologies and state of art facilities.

C) Program Educational Objectives of Civil Engineering Department

<table>
<thead>
<tr>
<th>PEO - 1</th>
<th>Graduates will utilize the foundation in Engineering and Science to improve lives and livelihoods through a successful career in Civil Engineering or other fields.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEO - 2</td>
<td>Graduates will become effective collaborators and innovators, leading or participating in efforts to address Social, Technical and Business challenges.</td>
</tr>
<tr>
<td>PEO - 3</td>
<td>Graduates will engage in Life-Long Learning and professional development through Self-Study, Continuing education or graduate and professional studies in engineering &amp; Business.</td>
</tr>
</tbody>
</table>

D) Program Outcomes of Civil Engineering Department
| PO1 | **Fundamental engineering analysis skills:** An ability to apply knowledge of computing, mathematical foundations, algorithmic principles, and civil engineering theory in the modelling and design of to civil engineering problems. |
| PO2 | **Information retrieval skills:** An ability to design and conduct experiments, as well as to analyses and interpret data. |
| PO3 | **Creative skills:** An ability to design, implement, and evaluate a system, process, component, or program to meet desired needs, within realistic constraints such as economic, environmental, social, political, health and safety, manufacturability, and sustainability. Graduates have design the competence. |
| PO4 | **Teamwork:** An ability to function effectively on multi-disciplinary teams. |
| PO5 | **Engineering problem solving skills:** An ability to analyze a problem, and identify, formulate and use the appropriate computing and engineering requirements for obtaining its solution. |
| PO6 | **Professional integrity:** An understanding of professional, ethical, legal, security and social issues and responsibilities. Graduates must understand the principles of ethical decision making and can interpret the ASCE Code of Ethics. Graduates will understand the proper use of the work of others (e.g., plagiarism, copyrights, and patents). Graduates will understand the special duty they we to protect the public's health, safety and welfare by their professional status as engineers in society. |
| PO7 | **Speaking / writing skills:** An ability to communicate effectively, both in writing and orally. Graduates can produce engineering reports using written, oral and graphic methods of communication. |
| PO8 | **Engineering impact assessment skills:** The broad education necessary to analyze the local and global impact of computing and engineering solutions on individuals, organizations, and society. |
| PO9 | **Social awareness:** Knowledge of contemporary issues. Students are aware of emerging technologies and current professional issues. |
| PO10 | **Practical engineering analysis skills:** An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. |
| PO11 | **Software hardware interface:** An ability to apply design and development principles in the construction of software and hardware systems of varying... |
E) Program Specific Outcomes of Civil Engineering Department.

**Competence in Civil Engineering:** Educating students with fundamental mathematical, scientific, and engineering knowledge to have a significant and positive long-term impact on the field of civil engineering.

**Usage of Cutting Edge Technology:** Inspiring students and preparing them for successful professional careers using appropriate techniques, resources and modern attitudes and modeling to complex engineering activities and research.

**Ability to Coordinate and communicate in groups:** Emphasizing the importance of working in a team effectively and to communicate properly within the team to achieve the desired outcome.

**Continuous improvement:** Motivate students in learning to learn and the ability to keep learning for a lifetime to increase their professionalism, update and deepen their knowledge through the development of the profession.

2. **SYLLABUS (University Copy)**

**UNIT – I**

**Introduction and Basic Concepts:** Introduction, Objectives, classification and principles of surveying, Scales, Shrinkage of Map, Conventional symbols and Code of Signals, Surveying accessories, phases of surveying.

**Measurement of Distances and Directions**

**Linear distances**- Approximate methods, Direct Methods- Chains- Tapes, ranging, Tape corrections, indirect methods- optical methods- E.D.M. method.

**Prismatic Compass**- Bearings, included angles, Local Attraction, Magnetic Declination, and dip.
UNIT - II

**Levelling and Contouring**

**Leveling**- Basics definitions, types of levels and levelling staves, temporary adjustments, methods of levelling, booking and Determination of levels- HI Method-Rise and Fall method, Effect of Curvature of Earth and Refraction.

**Contouring**- Characteristics and uses of Contours, Direct & Indirect methods of contour surveying, interpolation and sketching of Contours.

**Computation of Areas and Volumes**

**Areas** - Determination of areas consisting of irregular boundary and regular boundary (coordinates, MDM, DMD methods), Planimeter.

**Volumes** - Computation of areas for level section and two level sections with and without transverse slopes, determination of volume of earth work in cutting and embankments, volume of borrow pits, capacity of reservoirs.

UNIT - III

**Theodolite Surveying**: Types of Theodolites, Fundamental Lines, temporary adjustments, measurement of horizontal angle by repetition method and reiteration method, measurement of vertical Angle, Trigonometrical levelling when base is accessible and inaccessible.

**Traversing**: Methods of traversing, traverse computations and adjustments, Gale’s traverse table, Omitted measurements.

UNIT - IV

**Curves**: Types of curves and their necessity, elements of simple curve, setting out of simple Curves, Introduction to compound curves.

**Tacheometric Surveying**: Principles of Tacheometry, stadia and tangential methods of Tacheometry.

**Modern Surveying Methods**: principle and types of EDM.instruments, Total Station-advantages and applications, field procedure for total station survey, errors in total station survey, global positioning system-principle and applications.

UNIT – V

**Photogrammetry surveying**

Introduction, basic concepts, perspective geometry of aerial photograph, relief and tilt displacements, terrestrial photogrammetry, flight planning; stereoscopy, ground control extension for photographic mapping-aerial triangulation, radial triangulation, methods; photographic mapping-mapping using paper prints, mapping using stereoplottting instruments, mosaics, map substitutes.
TEXT BOOKS:

REFERENCES:
5. Surveying by Bhavikatti; Vikas publishing house ltd.
3. **A) COURSE OBJECTIVES**

1. To understand the importance of surveying in the field of civil engineering.
2. To study the basics of linear/angular measurement methods like chain surveying, compass surveying.
3. To study the significance of plane table surveying in plan making.
4. To know the basics of levelling and theodolite survey in elevation and angular measurements.
5. To understand tacheometric surveying in distance and height measurements

**B) COURSE OUTCOMES**

At the end of the course, the student will be able to:

1. Calculate angles, distances and levels.
2. Identify data collection methods and prepare field notes.
3. Understand the working principles of survey instruments.
4. Estimate measurement errors and apply corrections.
5. Interpret survey data and compute areas and volumes.

4. **Course Prerequisites**

Basic Mathematics.

5. **CO’s, PO’s Mapping**

<table>
<thead>
<tr>
<th>COs NO.</th>
<th>COs</th>
<th>POs</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Calculate angles, distances and levels.</td>
<td>PO1, PO4, PO11</td>
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<tr>
<td>CO2</td>
<td>Identify data collection methods and prepare field notes</td>
<td>PO2, PO3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the working principles of survey instruments.</td>
<td>PO1, PO3, PO5</td>
</tr>
<tr>
<td>CO4</td>
<td>Estimate measurement errors and apply corrections.</td>
<td>PO2, PO3</td>
</tr>
<tr>
<td>CO5</td>
<td>Interpret survey data and compute areas and volumes.</td>
<td>PO1, PO4</td>
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6. COURSE INFORMATION SHEET (CIS)

a). COURSE DESCRIPTION:

<table>
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<tr>
<th>PROGRAMME:</th>
<th>B. Tech. (Civil Engineering.)</th>
<th>DEGREE: B.TECH</th>
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<tr>
<td>COURSE:</td>
<td>SURVEYING and GEOMATICS</td>
<td>YEAR: II SEM: I</td>
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<td>COURSE CODE:</td>
<td>CE301PC</td>
<td>CREDITS: 3</td>
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<td>REGULATION:</td>
<td>R18</td>
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<td>COURSE AREA / DOMAIN:</td>
<td>Design</td>
<td>CONTACT HOURS: 4+1 (L+T) hours/Week.</td>
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<tr>
<td>CORRESPONDING LAB COURSE CODE (IF ANY):</td>
<td>NIL</td>
<td>LAB COURSE NAME: NIL</td>
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b). SYLLABUS:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Details</th>
<th>Hours</th>
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<tbody>
<tr>
<td>I</td>
<td><strong>Introduction and Basic Concepts</strong>: Introduction, Objectives, classification and principles of surveying, Scales, Shrinkage of Map, Conventional symbols and Code of Signals, Surveying accessories, phases of surveying. <strong>Measurement of Distances and Directions</strong> <strong>Linear distances</strong>: Approximate methods, Direct Methods- Chains- Tapes, ranging, Tape corrections, indirect methods- optical methods- E.D.M. method. <strong>Prismatic Compass</strong>: Bearings, included angles, Local Attraction, Magnetic Declination, and dip.</td>
<td>12</td>
</tr>
<tr>
<td>II</td>
<td><strong>UNIT - II</strong> <strong>Levelling and Contouring</strong> <strong>Levelling</strong>: Basics definitions, types of levels and levelling staves, temporary adjustments, methods of levelling, booking and Determination of levels- HI Method-Rise and Fall method, Effect of Curvature of Earth and Refraction. <strong>Contouring</strong>: Characteristics and uses of Contours, Direct &amp; Indirect methods of contour surveying, interpolation and sketching of Contours. <strong>Computation of Areas and Volumes</strong> <strong>Areas</strong>: Determination of areas consisting of irregular boundary and regular boundary (coordinates, MDM, DMD methods), Planimeter. <strong>Volumes</strong>: Computation of areas for level section and two level sections with and without transverse slopes, determination of volume of earth work</td>
<td>13</td>
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### III

**Theodolite Surveying:** Types of Theodolites, Fundamental Lines, temporary adjustments, measurement of horizontal angle by repetition method and reiteration method, measurement of vertical Angle, Trigonometrical levelling when base is accessible and inaccessible.

**Traversing:** Methods of traversing, traverse computations and adjustments, Gale’s traverse table, Omitted measurements.

### IV

**Curves:** Types of curves and their necessity, elements of simple curve, setting out of simple Curves, Introduction to compound curves.

**Tacheometric Surveying:** Principles of Tacheometry, stadia and tangential methods of Tacheometry.

**Modern Surveying Methods:** principle and types of EDM instruments, Total Station—advantages and applications. Field procedure for total station survey, errors in total station survey, global positioning system—principle and applications.

### V

**Photogrammetry surveying**

Introduction, basic concepts, perspective geometry of aerial photograph, relief and tilt displacements, terrestrial photogrammetry, flight planning; stereoscopy, ground control extension for photographic mapping—aerial triangulation, radial triangulation, methods; photographic mapping—mapping using paper prints, mapping using stereoplotting instruments, mosaics, map substitutes.

<table>
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<td>Lectures beyond syllabus</td>
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<tr>
<td>Tutorial classes</td>
<td>02</td>
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<tr>
<td>Classes for gaps &amp; Add-on classes</td>
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<tr>
<td>Total No. of classes</td>
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c). **GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:**

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<tr>
<td>1</td>
<td>Plane Table Surveying and its accessories</td>
<td>Class room Teaching &amp; Lab</td>
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<td>2</td>
<td>NIL</td>
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</table>

d). **TOPICS BEYOND SYLLABUS / ADVANCED TOPICS:**

| 1     | NIL                                              |                                   |
| 2     | NIL                                              |                                   |

e). **WEB SOURCE REFERENCES:**

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Name of book/ website</th>
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<tbody>
<tr>
<td>a.</td>
<td><a href="https://www.youtube.com/watch?v=vT_7OmzFiSE">https://www.youtube.com/watch?v=vT_7OmzFiSE</a></td>
</tr>
<tr>
<td>b.</td>
<td><a href="https://www.youtube.com/watch?v=COldgKBaiqw">https://www.youtube.com/watch?v=COldgKBaiqw</a></td>
</tr>
<tr>
<td>c.</td>
<td><a href="https://www.youtube.com/watch?v=j8poe2vvD2Q">https://www.youtube.com/watch?v=j8poe2vvD2Q</a></td>
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</tbody>
</table>

f). **DELIVERY / INSTRUCTIONAL METHODOLOGIES:**

- ☑ CHALK & TALK
- ☑ STUD. ASSIGNMENT
- ☑ WEB RESOURCES
- ☑ LCD/SMART BOARDS
- ☑ STUD. SEMINARS
- ☑ ADD-ON COURSES

g). **ASSESSMENT METHODOLOGIES - DIRECT**

<table>
<thead>
<tr>
<th>☑ ASSIGNMENTS</th>
<th>☑ STUD. SEMINARS</th>
<th>☑ TESTS/MODEL EXAMS</th>
<th>☑ UNIV. EXAMINATION</th>
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<tr>
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<td>☐ STUD. VIVA</td>
<td>☐ MINI/MAJOR PROJECTS</td>
<td>☐ CERTIFICATIONS</td>
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<tr>
<td>☑ ADD-ON COURSES</td>
<td>☐ OTHERS</td>
<td></td>
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</tbody>
</table>
h) ASSESSMENT METHODOLOGIES – INDIRECT

| ☑ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE) | ☑ STUDENT FEEDBACK ON FACULTY (TWICE) |
| ☐ ASSESSMENT OF MINI / MAJOR PROJECTS BY EXT. EXPERTS | ☐ OTHERS |

i) Text books & Reference books

TEXT / REFERENCE BOOKS:

<table>
<thead>
<tr>
<th>T/R</th>
<th>BOOK TITLE / AUTHORS / PUBLICATION</th>
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</table>
### 7. Topic wise Coverage [Micro Lesson Plan]

<table>
<thead>
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<th>S.No.</th>
<th>Topic</th>
<th>Planned date</th>
<th>Actual date</th>
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<td></td>
<td><strong>UNIT - I</strong></td>
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</tr>
<tr>
<td>1</td>
<td>Introduction and Basic Concepts: Introduction, Objectives</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>classification and principles of surveying</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Scales, Shrinkage of Map</td>
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<td></td>
</tr>
<tr>
<td>4</td>
<td>Conventional symbols and Code of Signals</td>
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<tr>
<td>5</td>
<td>Surveying accessories, phases of surveying,</td>
<td></td>
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<tr>
<td>6</td>
<td><strong>Measurement of Distances and Directions</strong></td>
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<tr>
<td>7</td>
<td>Linear distances- Approximate methods</td>
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<td>8</td>
<td>Direct Methods- Chains- Tapes, ranging, Tape corrections,</td>
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<td>9</td>
<td>Indirect methods- optical methods- E.D.M. method.</td>
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<tr>
<td>10</td>
<td><strong>Prismatic Compass</strong> - Bearings, included angles,</td>
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<td>Local Attraction, Magnetic Declination, and dip.</td>
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<td>12</td>
<td>Revision</td>
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<tr>
<td>13</td>
<td><strong>UNIT - II</strong></td>
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<tr>
<td>14</td>
<td>Levelling and Contouring</td>
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<tr>
<td>15</td>
<td>Levelling- Basics definitions, types of levels and levelling staves,</td>
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<tr>
<td>16</td>
<td>temporary adjustments, methods of levelling, booking</td>
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<tr>
<td>17</td>
<td>Determination of levels- HI Method-</td>
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<tr>
<td>18</td>
<td>Rise and Fall method, Effect of Curvature of Earth and Refraction.</td>
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<tr>
<td>19</td>
<td>Contouring- Characteristics and uses of Contours,</td>
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<tr>
<td>20</td>
<td>Direct &amp; Indirect methods of contour surveying, interpolation and sketching of Contours.</td>
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<tr>
<td>21</td>
<td><strong>Computation of Areas and Volumes</strong></td>
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<tr>
<td></td>
<td><strong>Areas</strong> - Determination of areas consisting of irregular boundary</td>
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<td>regular boundary (coordinates, MDM, DMD methods), Planimeter.</td>
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<td>Fundamental Lines, temporary adjustments</td>
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<td>Elements of simple curve.</td>
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<td>Aerial photogrammetry and terestrial photogrammetry</td>
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8. Teaching Schedule

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>Chapters Nos</th>
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<tr>
<td></td>
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<td>Book 1</td>
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<td>I</td>
<td>Introduction and Basic Concepts</td>
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<td>Measurement of Distances and Directions - Linear distances</td>
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<td>Levelling and Contouring</td>
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<td>Computation of Areas and Volumes</td>
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<td>Theodolite Surveying</td>
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<td>Traversing</td>
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<td>Tacheometric Surveying</td>
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<td>Photogrammetric surveying</td>
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<td>Contact classes for syllabus coverage</td>
<td>9</td>
<td>11</td>
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Contact classes for syllabus coverage **50**

Reference Books

- **Book 3** Surveying (Vol – 1, 2 & 3), by B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain - Laxmi Publications (P) ltd., New Delhi.
8. Softcopy Notes

Introduction:

- Surveying is defined as “taking a general view of, by observation and measurement determining the boundaries, size, position, quantity, condition, value etc. of land, estates, building, farms mines etc. and finally presenting the survey data in a suitable form”. This covers the work of the valuation surveyor, the quantity surveyor, the building surveyor, the mining surveyor and so forth, as well as the land surveyor.

- Another school of thought define surveying “as the act of making measurement of the relative position of natural and manmade features on earth’s surface and the presentation of this information either graphically or numerically. The process of surveying is therefore in three stages namely:

(i) Taking a general view
This part of the definition is important as it indicates the need to obtain an overall picture of what is required before any type of survey work is undertaken. In land surveying, this is achieved during the reconnaissance study.

(ii) Observation and Measurement
This part of the definition denotes the next stage of any survey, which in land surveying constitutes the measurement to determine the relative position and sizes of natural and artificial features on the land.

(iii) Presentation of Data:
The data collected in any survey must be presented in a form which allows the information to be clearly interpreted and understood by others. This presentation may take the form of written report, bills of quantities, datasheets, drawings and in land surveying maps and plan showing the features on the land.

Types of Surveying
On the basis of whether the curvature of the earth is taken into account or not, surveying can be divided into two main categories:

Plane surveying: is the type of surveying where the mean surface of the earth is considered as a plane. All angles are considered to be plane angles. For small areas less than 250 km2 plane surveying can safely be used. For most engineering projects such as canal, railway, highway, building, pipeline, etc constructions, this type of...
surveying is used. It is worth noting that the difference between an arc distance of 18.5 km and the subtended chord lying in the earth’s surface is 7mm. Also the sum of the angles of a plane triangle and the sum of the angles in a spherical triangle differ by 1 second for a triangle on the earth’s surface having an area of 196 km²

Under revision

Geodetic surveying: is that branch of surveying, which takes into account the true shape of the earth (spheroid).

Classification of surveying

Introduction

For easy understanding of surveying and the various components of the subject, we need a deep understanding of the various ways of classifying it.

Objective

To enable the students have understanding of the various ways of classifying surveying

Classification of Surveying

Surveying is classified based on various criteria including the instruments used, purpose, the area surveyed and the method used.

Classification on the Basis of Instruments Used.

Based on the instrument used; surveys can be classified into;

i) Chain tape surveys

ii) Compass surveys

iii) Plane table surveys

iv) Theodolite surveys

Classification based on the surface and the area surveyed

i) Land survey

Land surveys are done for objects on the surface of the earth. It can be subdivided into:

(a) Topographic survey: This is for depicting the (hills, valleys, mountains, rivers, etc) and manmade features (roads, houses, settlements…) on the surface of the earth.

(b) Cadastral survey is used to determining property boundaries including those of fields, houses, plots of land, etc.
(c) Engineering survey is used to acquire the required data for the planning, design and Execution of engineering projects like roads, bridges, canals, dams, railways, buildings, etc.

Under revision

(d) City surveys: The surveys involving the construction and development of towns including roads, drainage, water supply, sewage street network, etc, are generally referred to as city survey.

(2) Marine or Hydrographic Survey: Those are surveys of large water bodies for navigation, tidal monitoring, the construction of harbours etc.

(3) Astronomical Survey:
Astronomical survey uses the observations of the heavenly bodies (sun, moon, stars etc) to fix the absolute locations of places on the surface of the earth.

CLASSIFICATION ON THE BASIS OF PURPOSE

i) Engineering survey

ii) Control Survey:
Control survey uses geodetic methods to establish widely spaced vertical and horizontal control points.

iii) Geological Survey
Geological survey is used to determine the structure and arrangement of rock strata. Generally, it enables to know the composition of the earth.

iv) Military or Defence Survey is carried out to map places of military and strategic Importance

iv) Archeological survey is carried out to discover and map ancient/relics of antiquity.

Classification Based On Instrument Used

i. Chain/Tape Survey: This is the simple method of taking the linear measurement using a chain or tape with no angular measurements made.

ii. Compass Survey: Here horizontal angular measurements are made using magnetic compass with the linear measurements made using the chain or tape.

iii. Plane table survey: This is a quick survey carried out in the field with the measurements and drawings made at the same time using a plane table.

iv. Leveling
This is the measurement and mapping of the relative heights of points on the earth’s surface showing them in maps, plane and charts as vertical sections or with conventional symbols.

Vi. Theodolite Survey:
Theodolite survey takes vertical and horizontal angles in order to establish controls

CLASSIFICATION BASED ON THE METHOD USED
1. Triangulation Survey
In order to make the survey, manageable, the area to be surveyed is first covered with series of triangles. Lines are first run round the perimeter of the plot, then the details fixed in relation to the established lines. This process is called triangulation. The triangle is preferred as it is the only shape that can completely over an irregularly shaped area with minimum space left.

ii. Traverse survey:
If the bearing and distance of a place of a known point is known: it is possible to establish the position of that point on the ground. From this point, the bearing and distances of other surrounding points may be established. In the process, positions of points linked with lines linking them emerge. The traversing is the process of establishing these lines, is called traversing, while the connecting lines joining two points on the ground. Joining two while bearing and distance is known as traverse. A traverse station is each of the points of the traverse, while the traverse leg is the straight line between consecutive stations. Traverses may either be open or closed.

1. Closed Traverse:
When a series of connected lines forms a closed circuit, i.e. when the finishing point coincides with the starting point of a survey, it is called as a ‘closed traverse’, here ABCDEA represents a closed traverse. (Fig 2.1 (a)) Fig 2.1 (a) Closed traverse is suitable for the survey of boundaries of ponds, forests etc.

2. Open Traverse:
When a sequence of connected lines extends along a general direction and does not return to the starting point, it is known as ‘open traverse’ or (unclosed traverse). Here ABCDE represents an open traverse. Fig 2.2 (b)

BASIC PRINCIPLES IN SURVEYING
PRINCIPLE OF WORKING FROM WHOLE TO PART
• It is a fundamental rule to always work from the whole to the part. This implies a precise control surveying as the first consideration followed by subsidiary detail surveying.

• This surveying principle involves laying down an overall system of stations whose positions are fixed to a fairly high degree of accuracy as control, and then the survey of details between the control points may be added on the frame by less elaborate methods.

• Once the overall size has been determined, the smaller areas can be surveyed in the knowledge that they must (and will if care is taken) put into the confines of the main overall frame.

• Errors which may inevitably arise are then contained within the framework of the control points and can be adjusted to it.

Surveying is based on simple fundamental principles which should be taken into consideration to enable one get good results.

(a) Working from the whole to the part is achieved by covering the area to be surveyed with a number of spaced out control point called primary control points whose pointing have been determined with a high level of precision using sophisticated equipments. Based on these points as theoretic, a number of large triangles are drawn. Secondary control points are then established to fill the gaps with lesser precision than the primary control points. At a more detailed and less precise level, tertiary control points at closer intervals are finally established to fill in the smaller gaps. The main purpose of surveying from the whole to the part is to localize the errors as working the other way round would magnify the errors and introduce distortions in the survey. In partial terms, this principle involve covering the area to be surveyed with large triangles. These are further divided into smaller triangles and the process continues until the area has been sufficiently covered with small triangles to a level that allows detailed surveys to be made in a local level. Error is in the whole operation as the vertices of the large triangles are fixed using higher precision instruments.

(b) Using measurements from two control parts to fix other points. Given two points whose length and bearings have been accurately determined, a line can be drawn to join them hence surveying has control reference points. The locations of various other points and the lines joining them can be fixed by measurements made from these two
points and the lines joining them. For an example, if A and B are the control points, the following operations can be performed to fix other points.

i) Using points A and B as the centers, ascribe arcs and fix (where they intersect).

ii) Draw a perpendicular from D along AB to a point C.

iii) To locate C, measure distance AB and use your protractor to equally measure angle ABC.

iv) To locate C the interior angles of triangle ABC can be measured. The lengths of the sides AC and BC can be calculated by solving the triangle.

Fig. 6.1: Fixing the third points using two points

The process of surveying:

The survey process passes through 3 main phases – the reconnaissance, field work and measurements, and, the office work.

(a) Reconnaissance survey

This is a pre-field work and measurement phase. It requires taking an overall inspection of the area to be surveyed to obtain a general picture before commencement of any serious survey. Walking through the site enables one to understand the terrain and helps in determining the survey method to be adopted, and the scale to be used. The initial information obtained in this stage helps in the successful planning and execution of the survey.

(b) Field work and measurement:

This is the actual measurements in the field and the recordings in the field notebook. To get the best results in the field, the surveyor must be acquainted with the functions of the equipments and take good care of them.

(c) Office work: This is the post field work stage in which data collected and recordings in the field notebooks are decoded and used to prepare the charts, planes and maps for presentation to the clients and the target audience.

CHAIN SURVEYING

This is the simplest and oldest form of land surveying of an area using linear measurements only. It can be defined as the process of taking direct measurement, although not necessarily with a chain.

EQUIPMENTS USED IN CHAIN SURVEYING
These equipments can be divided into three, namely

(i) Those used for linear measurement. (Chain, steel band, linear tape)

(ii) Those used for slope angle measurement and for measuring right angle (Eg. Abney level, clinometer, cross staff, optical squares)

(iii) Other items (Ranging rods or poles, arrows, pegs etc).

1. Chain: The chain is usually made of steel wire, and consists of long links joined by shorter links. It is designed for hard usage, and is sufficiently accurate for measuring the chain lines and offsets of small surveys. Chains are made up of links which measure 200mm from centre to centre of each middle connecting ring and surveying brass handless are fitted at each end. Tally markers made of plastic or brass are attached at every whole metre position or at each tenth link. To avoid confusion in reading, chains are marked similarly form both end (E.g. Tally for 2m and 18m is the same) so that measurements may be commenced with either end of the chain. There are three different types of chains used in taking measurement namely:

   i. Engineers chain
   ii. Gunter’s chain
   iii. Steel bands

Methods of Levelling:

1. Height of Collimation Method
2. Rise and Fall Method

1. Collimation Method:
   It consist of finding the elevation of the plane of collimation (H.I.) for every set up of the instrument, and then obtaining the reduced level of point with reference to the respective plane of collimation.
   1. Elevation of plane of collimation for the first set of the level determined by adding back side to R.L. of B.M.
   2. The R.L. of intermediate point and first change point are then obtained by starching the staff reading taken on respective point (IS & FS) from the elevation of the plane collimation. [H.I.]
   3. When the instrument is shifted to the second position a new plane collimation is set up. The elevation of this plane is obtained by adding B.S. taken on the C.P. From the
second position of the level to the R.L. C.P. The R.L. of successive point and second C.P. are found by subtract these staff reading from the elevation of second plane of collimation Arithmetical check Sum of B.S. – sum of F.S. = last R.L. – First R.L.

2. Rise and Fall Method:
It consists of determining the difference of elevation between consecutive points by comparing each point after the first that immediately preceding it. The difference between there staff reading indicates a rise fall according to the staff reading at the point. The R.L is then found adding the rise to, or subtracting the fall from the reduced level of preceding point.

Arithmetic check
Sum of B.S. – sum of F. S. = sum of rise – sum of fall = last R. L. – first R.L.

Basic definitions

Bench Mark and Reference Datum
In order to calculate the heights of points a datum is required, i.e. a reference level. This is usually the mean sea level. For this purpose, the use of Bench Marks is necessary, and these are classified as follows: Bench Mark (BM) – a point with known height above mean sea level (or other reference datum). These are permanent points (e.g. unchanged by weather conditions) and are provided by the Department of Lands and Surveys.

Reduced Level
The height of any target point is referred to as Reduced Level (RL), because it is reduced to a known datum.

Backsight (BS)
First staff reading taken immediately after setting up the instrument.

Foresight (FS)
Last staff reading taken before moving the instrument to another location.

Intermediate sight (IS)
All readings taken between a BS and a FS.

9. OHP/LCD SHEETS /CDS/DVDS/PPT (Soft/Hard copies).
10. University Previous Question papers.

Code No: 113AM

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech II Year I Semester Examinations, November/December - 2016
SURVEYING
(Common to CE, CEE, AGE)

Time: 3 Hours
Max. Marks: 75

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART-A

(25 Marks)

1. a) What are the different types of chains? [2]
   b) Mention different types of scales used in surveying and give the significance of each. [3]
   c) What do you mean by a contour? [2]
   d) Mention different types of temporary adjustments. [3]
   e) What is a field note book? [2]
   f) Draw different types of embankment. [3]
   g) Mention different types of traversing. [2]
   h) List out the permanent adjustments in theodolite? [3]
   i) Differentiate simple and compound curves. [2]
   j) Mention three segments of GPS. [3]

PART-B

(50 Marks)

2. Explain the different methods of plane table surveying with neat diagram. [10]

3. OR
   Explain the working principle of EDM with suitable diagram. [10]

4. OR
   Define levelling and discuss different types of levelling in detail. [10]

5. OR
   What are the different methods of contour surveying and plotting? Discuss in detail. [10]

6. OR
   How to calculate area of regular and irregular boundaries? Explain. [10]

7. OR
   Discuss the different methods of estimating capacity of a reservoir in detail. [10]

8. OR
   What is the working principle of electronic theodolite? Explain. [10]

9. OR
   Explain repetition and reiteration methods in detail with neat sketches. [10]

10. OR
    Mention the different components of GPS and explain each of them. [10]

   OR
   Give the classification of EDM and explain the phase correction in EDM. [10]

---oo0oo---
MAHANTESH N PARUTI

SURVEYING AND GEOMATICS

Code No: 133BU
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech II Year I Semester Examinations, November/December - 2017
SURVEYING
(Common to EE, CEE)
Max. Marks: 75

Time: 3 Hours

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit.
Each question carries 10 marks and may have a, b, c as sub questions.

PART-A
(25 Marks)
b) What is local attraction? How will you determine it in a closed traverse? [3]
c) What do you understand by contour interval and on what factors does it depend? [2]
d) How a horizontal surface is different from a level surface? [3]
e) What are the different types of sources of errors in a Thedolite work? [2]
f) What are the advantages of Trigonometric leveling over direct leveling? [3]
g) What is meant by Degree of curve? Give relation with the radius of curve. [2]
h) Explain the functions of the following curves:
i) simple circular curve ii) reverse curve. [3]
j) What are the various applications of GPS in Civil Engineering field? [2]
k) What are the various types of EDM instruments? [3]

PART-B
(50 Marks)
2. Define surveying. Discuss briefly the classification of surveying based on:
i) Purpose ii) Instruments.

3. a) What is the limit of accuracy in compass surveying? [2]
b) Below are the bearings observed in a traverse survey conducted with a prismatic compass at a place where local attractions was suspected.

<table>
<thead>
<tr>
<th>Line</th>
<th>F.B</th>
<th>B.B</th>
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<tbody>
<tr>
<td>PO</td>
<td>124°30</td>
<td>304°30</td>
</tr>
<tr>
<td>QR</td>
<td>68°15</td>
<td>246°0</td>
</tr>
<tr>
<td>RS</td>
<td>310°30</td>
<td>135°15</td>
</tr>
<tr>
<td>SP</td>
<td>200°15</td>
<td>17°45</td>
</tr>
</tbody>
</table>

At what stations do you suspect local attraction? Find the corrected bearings of the lines and also calculate the included angles. [7+3]

4. a) The following staff readings were taken with a level. The instrument having been shifted after the 4th, 7th and 10th readings. The R.L of the starting point(B.M) is 100.00m. Enter the readings in the form of a level book page and reduce the level by the collimation method and apply the usual checks.

2.65, 3.74, 3.83, 5.27, 4.64, 0.38, 0.96, 1.64, 2.84, 3.48, 4.68 and 5.26.
b) Distinguish between Line of collimation and line of sight. [7+3]
8.a) Explain briefly the different methods of traversing with a theodolite.
b) Describe the process of permanent adjustment in a transit theodolite. [5+5]

OR

9.a) A theodolometer was set up at a station C and the following readings were obtained on a staff vertically held.

<table>
<thead>
<tr>
<th>Instrument station</th>
<th>Staff Station</th>
<th>Vertical Angle</th>
<th>Hair readings (m)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>BM</td>
<td>-6°20'</td>
<td>1.150, 1.8, 2.45</td>
<td>RL of BM =</td>
</tr>
<tr>
<td>C</td>
<td>D</td>
<td>+ 9°15'</td>
<td>0.750, 1.5, 2.25</td>
<td>780.25m</td>
</tr>
</tbody>
</table>

Calculate the horizontal distance CD and RL of D. Consider K as 100 and C as 0
b) Explain the construction of a theodolite instrument with a neat sketch. [5+5]

10.a) Two tangents intersect at a chainage of 1190m, the deflection angle being 36°. Compute all the data necessary to set out a curve of radius 300m by offset from long chord produced.
b) Explain briefly the applications of GIS and GPS in surveying. [5+5]

OR

11.a) A Tachometer was kept at a station P and observations were made to a stadia rod kept at station Q, the stadia reading were 1.135, 2.05 and 2.965 m. The reading on a staff held at a BM of RL 110.95m was 2.135m find the distance PQ and the RL of point P.
b) Explain with neat sketch the construction of Electronic distance meter. Elaborate its uses in computation of measurements. [5+5]
4.a) Reciprocal leveling was done between two points A and B situated on the opposite sides of a valley 750m wide. The following data was collected:

<table>
<thead>
<tr>
<th>Instrument at</th>
<th>Height of Instrument</th>
<th>Staff at</th>
<th>Staff reading (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.463</td>
<td>B</td>
<td>1.688</td>
</tr>
<tr>
<td>B</td>
<td>1.463</td>
<td>A</td>
<td>0.991</td>
</tr>
</tbody>
</table>

Determine the difference in level between A and B and the amount of collimation error if any.

b) Explain the methods of contour plotting. [5+5]

5.a) The following consecutive readings were taken with a dumpy level and 4m leveling staff on a continuously sloping ground at 30m intervals: 0.680, 1.455, 1.855, 2.330, 2.885, 3.380, 1.055, 1.860, 2.265, 3.540, 0.835, 0.945, 1.530 and 2.250.

The RL of starting point was 80.750m

i) Rule out a page of the level book and enter the above readings.

ii) Carry out reduction of heights by rise and fall method and apply the usual checks.

Determine the gradient of the line joining the first and last point.

b) Explain when reciprocal levelling is done? Describe the method along with a neat sketch. [5+5]

6.a) The following offset were taken from a chain line to an irregular boundary line:

<table>
<thead>
<tr>
<th>Chainage (m)</th>
<th>Offset (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0, 6.5, 16.2, 27.2, 39.6</td>
<td>3.5, 4.75, 5.2, 6.30, 7.36</td>
</tr>
</tbody>
</table>

Calculate the area between the chain line and the boundary.

b) At a station, a trench was measured and found to be 1m wide and 1.25m deep. At the next station 10m away from the first one it was 1.1m wide and 2.7m deep.

Determine the volume of earthwork between two stations. [5+5]

7.a) For a proposed new road, the cross-sectional areas at different sections are as follows:

<table>
<thead>
<tr>
<th>Chainage (m)</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>16.4</td>
</tr>
<tr>
<td>1020</td>
<td>29.1</td>
</tr>
<tr>
<td>1040</td>
<td>35.4</td>
</tr>
<tr>
<td>1060</td>
<td>32.6</td>
</tr>
<tr>
<td>1080</td>
<td>29.4</td>
</tr>
<tr>
<td>1100</td>
<td>18.5</td>
</tr>
<tr>
<td>1120</td>
<td>9.5</td>
</tr>
</tbody>
</table>

Calculate the volume enclosed between chainage 1000m and 1120m by the prismoidal and end area formulae.

b) The following offsets were taken from a chain line to an irregular boundary line at an interval of 10 m: 0, 2.50, 3.50, 5.00, 4.60, 3.20, 0 m. Compute the area between the chain line, the irregular boundary line and the end of offsets by:

i) mid ordinate rule, ii) the average _ordinate rule, iii) the trapezoidal rule.

iv) Simpson’s rule. [5+5]
SURVEYING AND GEOMATICS

Code No: 113AM
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech II Year I Semester Examinations, November/December - 2017
SURVEYING
(Common to CE, AGE)

Time: 3 Hours
Max. Marks: 75

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit.
Each question carries 10 marks and may have a, b, c as sub questions.

PART-A
(25 Marks)

1.a) What are the principles of surveying? [2]
   b) List the methods of plotting compass traverse. [3]
   c) What are the sources of error in computation of area? [2]
   d) List the application of contour lines. [3]
   e) Write the expression for calculation of volume using prismoidal method. [2]
   f) What do mean by face left and right position in a theodolite instrument? [3]
   g) List the variation of magnetic declination. [2]
   h) What is the principle of tacheometric surveying? [3]
   i) What is the difference between horizontal and vertical curve. [2]
   j) What are the vector data over raster data in GIS? [3]

PART-B
(50 Marks)

2.a) A Survey line crosses a river, A and C being on the near and opposite banks
respectively. A perpendicular AD 40m long is set out at A. If the bearing of AD
and DC are 38°45' & 278°45' respectively and the chainage at A is 862 m. Find
the chainage at B.
   b) Explain with neat sketches for different accessories used in plane table survey. [5+5]

OR

3.a) The followings bearings were observed while conducting a close traverse with a
compass in a place where local attraction was suspected:

<table>
<thead>
<tr>
<th>Line</th>
<th>Fore Bearing</th>
<th>Back Bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>PQ</td>
<td>80°45'</td>
<td>260°00'</td>
</tr>
<tr>
<td>QR</td>
<td>130°30'</td>
<td>310°35'</td>
</tr>
<tr>
<td>RS</td>
<td>240°15'</td>
<td>60°15'</td>
</tr>
<tr>
<td>SP</td>
<td>290°30'</td>
<td>110°10'</td>
</tr>
</tbody>
</table>

At what stations do you suspect local attraction? Find the corrected bearings of
the lines and the included angles.

b) A river is flowing from west to east. For determining the width of the river, two
points C and D are selected on the southern bank such that the distance
CD = 150m. Points C is west wards. The bearings at a tree ‘Q’ on the northern
bank are observed to be 45° and 335° respectively from C and D. calculate the
width of the river. [5+5]
How do you determine the capacity of a reservoir using contours.

The following offsets were taken in meters from a chain line to a hedge:

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>0</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>150</th>
<th>180</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offset</td>
<td>9.4</td>
<td>10.8</td>
<td>12.5</td>
<td>10.5</td>
<td>14.5</td>
<td>13.0</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Compute the area included between the chain line, the hedge and end offset by the Simpson's rule.

6. Determine the gradient from a point P to another point Q from the following observations made with a tacheometer fitted with an anallactic lens. The constant of the instrument was 100 and the staff was held vertical.

<table>
<thead>
<tr>
<th>Instrument station</th>
<th>Staff station</th>
<th>Bearing</th>
<th>Vertical angle</th>
<th>Staff readings (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>P</td>
<td>130°</td>
<td>+10°32</td>
<td>1.255, 1.810, 2.365</td>
</tr>
<tr>
<td></td>
<td>Q</td>
<td>22°20</td>
<td>+5°06</td>
<td>1.300, 2.120, 2.940</td>
</tr>
</tbody>
</table>

7a) What are the different errors in theodolite work?
b) What are the limits of precision in theodolite traversing?

8. A tacheometer was setup at station A and the following readings were obtained on a vertically held staff:

<table>
<thead>
<tr>
<th>Station</th>
<th>Staff station</th>
<th>Vertical angle</th>
<th>Hair readings</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td></td>
<td>+8°36</td>
<td>1.650, 2.515, 3.380</td>
<td></td>
</tr>
</tbody>
</table>

Calculate the horizontal distance from A to B and the R.L. of B, if the constants of the instruments were 100 and 0.4.

9a) What are the different methods of designation of a curve?
b) Draw a neat sketch of a circular curve and show its various elements thereon.

10a) Explain what are the latest advancements in total station techniques and their significance.
b) What are the uses of an electronic Total station?

11a) Explain various segments of GPS.
b) Write down various applications of GPS.
11. MID exam Descriptive Question Papers with Key.

1. What are the objectives of surveying? Also explain the fundamental principles of surveying.
2) a) What are the characteristics of contour?
   b) What are the methods of levelling? Explain any one method.
3 ) The following staff readings were observed successfully with a level. The instrument having been moved after 3rd, 6th and 8th readings.
2.228, 1.6606, 0.9882, 0.0902, 0.864, 1.262, 0.602, 1.982, 1.0442, 2.684 m. Enter the above reading in a page level book and calculate RL of points if the first reading is taken with the staff and held a BM of 432.384 m.
4) The following bearings when observed in the compass traverse at which the stations would local attraction be suspected? find the correct bearings of the line.

<table>
<thead>
<tr>
<th>Line</th>
<th>AB</th>
<th>BC</th>
<th>CD</th>
<th>DE</th>
<th>EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fore</td>
<td>305°00'</td>
<td>75°30'</td>
<td>115°30'</td>
<td>165°30'</td>
<td>225°00'</td>
</tr>
<tr>
<td>bearing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back</td>
<td>125°30'</td>
<td>254°30'</td>
<td>345°30'</td>
<td>44°00'</td>
<td>125°30'</td>
</tr>
<tr>
<td>bearing</td>
<td></td>
<td>297°00'</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. MID exam Objective Question papers with Key.

1. The chain correction for sag is [ B ]
   A. Always additive  B. Always subtractive  C. Always zero  D. Sometimes additive and sometimes subtractive
2. The 20 meter chain is divided into [ B ]
   A. 150 links  B. 100 links  C. 200 links  D. 250 links
3. Inclination of the needle to the horizontal towards the pole is called as [ A ]
   A. Dip  B. Declination  C. Azimuth  D. Bearing
4. The length of the Gunter’s chain is [ D ]
   A. 100 ft  B. 50 ft  C. 62 ft  D. 66 ft
5. Theodolite is an instrument used for [ D ]
   A. measurement of bearings only  B. measurement of horizontal only  C. measurement of vertical angle  D. all the above
6. Which of the following is the most precise instrument for measuring horizontal distances [ D ]
   A. chain  B. tape  C. Tachometer  D. Tellurometer

7. The temporary adjustments of surveyor compass involve [ D ]
   A. centering only  B. levelling only  C. centering and levelling
   D. centering, levelling and focusing the prism

8. An imaginary line passing through points of equal elevation[ A]
   A. contour  B. contour interval  C. horizontal equivalent  D. all the above

09. In metric chain, number of links per meter can be [ B ]
    A. 2  B. 5  C.8  D. 10

10. In chain surveying field work is limited to [ B]
    A. Both linear and angular measurements  B. Linear measurements only
    C. Angular measurements only  D. a),b),and c).

II Fill in the Blanks:

11. The bearing of a line in the direction of progress of the line…Fore bearing…………

12. The horizontal angle between true north and magnetic north at the time of observation……magnetic declination…

13. Closed contours of decreasing values towards their center, represents……hilly……

14. It is the RL difference between two adjust contour…contour interval……

15. The true length of the chain=…l’/L X MI……

16. Linen tape is made up of……linen……

17. The main principle of surveying is to work from…whole to part……

18. It is the horizontal distance between any two points on two consecutive contours……horizontal equivalent..

19. Chain survey is well adopted for……small areas…..

20. Correction due to refraction is given by…-0.0012d^2
13. Assignment topics with materials

14. Tutorial topics and Questions.

15. Unit wise-Question bank

UNIT – I
1. Two marks question with answers
   a) Define Surveying.
      Ans: Surveying or land surveying is the technique, profession, and science of
determining the terrestrial or three-dimensional positions of points and the
distances and angles between them. A land surveying professional is called a land
surveyor. These points are usually on the surface of the Earth, and they are often
used to establish maps and boundaries for ownership, locations, such as building
corners or the surface location of subsurface features, or other purposes required
by government or civil law, such as property sales.
   b) State the Principle of surveying
      Ans: Principles of Surveying
      The fundamental principle upon which the various methods of plane surveying are
      based can be stated under the following two aspects.
      Location of a point by measurement from two points of reference
      According to this principle, the relative position of a point to be surveyed should be
      located by measurement from at least two points of reference, the positions of which
      have already been fixed.
If P and Q are the two reference points on the ground, any other point, such as R, can be located by any of the direct methods shown in the above figures. But, although a single method is sufficient to locate the relative position of ‘R’ with respect to reference points P and Q, it is necessary to adopt at least any two methods to fix the position of point ‘R’.

While the measurements made in the either of the first method or second method will be helpful in locating the point ‘R’, the measurements made in the other method will act as a check.

**Working from whole to part**
According to this principle, it is always desirable to carryout survey work from whole to part. This means, when an area is to be surveyed, first a system of control points is to be established covering the whole area with very high precision. Then minor details are located by less precise methods.

c) **State the two Primary division of surveying.**

Ans: **Primary types of Surveying are:**

1. **Plane surveying**
   
   Plane surveying is conducted by state agencies as well as private agencies. As we know earth is spherical in shape but its diameter is big enough to consider plane in small dimensions. It is that type of surveying in which the mean surface of the earth is considered as a plane and the spheroidal shape is neglected. All triangles formed by survey lines are considered as plane triangles. The level line is considered as straight and plumb lines are considered parallel. Plane surveying is done of the area of survey is less than 250 km$^2$.

2. **Geodetic surveying**

   Geodetic survey is conducted by survey department of the country. It is that type of surveying in which the curved shape of the earth is taken in to account. The object of geodetic survey is to determine the precise position on the surface of the earth, of a system of widely distant points which form control stations in which surveys of less precision may be referred. Line joining two points is considered as curved line and angles are assumed as spherical angles. It is carried out if the area exceeds over 250 km$^2$.

d) **What are the different types of chains.**

Ans: Types of Chains used in Surveying

Depending upon the length of the chain, these are divide into following types,

   i) Metric chains
   ii) Steel band or Band chain
   iii) Gunter’s chain or surveyor’s chain
   iv) Engineer’s chain
   v) Revenue chain
Metric chains

Metric chains are the most commonly used chain in India. These types of chains come in many lengths such as 5, 10, 20 and 30 meters. Most commonly used is 20m chain. Tallies are provided at every 2m of the chain for quick reading. Every link of this type of chain is 0.2m. The total length of the chain is marked on the brass handle at the ends.

Steel band or Band chain

These types of chain consist of a long narrow strip of steel of uniform width of 12 to 16 mm and thickness of 0.3 to 0.6 mm. This chain is divides by brass studs at every 20cm or instead of brass studs, band chain may have graduated engraving as centimeter.

For easy use and workability band chains are wound on steel crosses or metal reels from which they can be easily unrolled. These steel bands are available in 20m and 30m length and the width of about 12-16mm.

Gunter’s chain or surveyor’s chain

Gunter chain comes in standard 66ft. These chain consists of 100 links, each link being 0.66ft or 7.92 inches. The length 66ft is selected because it is convenient in land measurements.

10 square Gunter’s chains = 1 Acre

10 Gunter chains = 1 Furlong

80 Gunter chains = 1 mile

Engineer’s chain

This chain comes in 100ft length. Its consist of 100 links each link being 1ft long. At every 10 links a brass ring or tags are provided for indication of 10 links. Readings are taken in feet and decimal.

Revenue Chain
The standard size of this type of chain is 33ft. The number of links are 16, each link being 2 1/16 ft. This chain is commonly used in cadastral survey.

e) State the types of errors in chain

**Ans: Errors in chain Surveying**

Errors in chaining may be classified as:

- Personal errors
- Compensating errors, and
- Cumulating errors.

**Personal Errors**
Wrong reading, wrong recording, reading from wrong end of chain etc., are personal errors. These errors are serious errors and cannot be detected easily. Care should be taken to avoid such errors.

**Compensating Errors**
These errors may be sometimes positive and sometimes negative. Hence they are likely to get compensated when large number of readings are taken. The magnitude of such errors can be estimated by theory of probability. The following are the examples of such errors:

- Incorrect marking of the end of a chain.
- Fractional part of chain may not be correct though total length is corrected.
- Graduations in tape may not be exactly same throughout.
- In the method of stepping while measuring sloping ground, plumbing may be crude.

**Cumulative Errors**
The errors that occur always in the same direction are called cumulative errors. In each reading the error may be small, but when large number of measurements are made they may be considerable, since the error is always on one side. Examples of such errors are:

1. Bad ranging
2. Bad straightening
3. Erroneous length of chain
4. Temperature variation
5. Variation in applied pull
6. Non-horizontality
7. Sag in the chain, if suspended for measuring horizontal distance on a sloping ground.

Errors (i), (ii), (vi) and (vii) are always +ve since they make measured length more than actual.

2. Three marks question with answers
   a) What are the different types of tapes

   Ans: Types of Measuring Tapes in Surveying

   Tapes are made of different materials:

   1. Cloth or linen tape
      - Used for subsidiary measurements.
      - Very light, easy to handle.
      - May effect by moisture

   2. Metric steel tape
      - Made of steel.
      - Outer end is provided with a ring for holding

   3. Invar tape
      - Used for high precision work.
      - Made of alloy steel

   4. Synthetic tape
      - Made of glass fiber with PVC coating
      - These are used for short measurements

   b) What are the different types of compasses

   Ans: Following are the two main types of a compass.
Prismatic Compass: Prismatic compass is useful for filling in details in a survey and in places where the ground does not allow the use of chaining. It is used by the military for reconnaissance survey, might motility and for sketching along roads or rivers.

Surveyor Compass: It is used to determine the magnetic bearing of a given line and is usually used in connection with the chain or compass survey.

c) Define Magnetic Bearing
Ans: The horizontal angle which a line makes with the magnetic meridian measured from Magnetic North line is called magnetic bearing. It varies with time. Magnetic meridian of a line can be measured in the field by using prismatic compass.

d) Define True Bearing
Ans: True Bearing: The true bearing of a line is the horizontal angle between the true meridian and the survey line. The true bearing is measured from the true north in the clockwise direction.

e) Define Arbitrary Bearing
Ans: Arbitrary Bearing: It is the horizontal angle which a survey line makes with any arbitrary meridian, which is any convenient direction towards a permanent and prominent mark or signal, such as a church spire or top of a chimney. Such bearings are used to determine the relative position of line in a small area.

3. Five marks question with answers
a) Give the classification of surveying in brief based up on Nature of field.

b) A 20m chain used for a survey was found to be 20.10 m at the beginning and 20.30 m at the end of the work. The area of the plan drawn to a scale of 1cm= 8m was measured with the help of a planimeter and was found to be 32.56 sq.cm find the true area of the field.

c) A 30m chain used for a survey was found to be 20.10 m at the beginning and 20.50 m at the end of the work. The area of the plan drawn to a scale of 1cm= 6m was measured with the help of a planimeter and was found to be 32.56 sq.cm find the true area of the field.

d) A 20m chain was found to be 10cm too long after chaining a distance of 1500m. It was found to be 18 cm too long at the end of the day’s work after chaining a total
distance of 2900m. Find the true distance if the chain was corrected before the commencement of the work.

e) A line was measured with a steel tape which is exactly 30m long at 180°C and found to be 452.343 m. The temperature during measurement was 320°C. Find the true length of the line. Take coefficient of thermal expansion of tape 0°C = 0.0000117

UNIT – II

1. Two marks question with answers

a) Define Leveling
Ans: Levelling (or Leveling) is a branch of surveying, the object of which is: i) to find the elevations of given points with respect to a given or assumed datum, and ii) to establish points at a given or assumed datum. The first operation is required to enable the works to be designed while the second operation is required in the setting out of all kinds of engineering works. Levelling deals with measurements in a vertical plane.

b) Define level surface
Ans: Level surface: A level surface is defined as a curved surface which at each point is perpendicular to the direction of gravity at the point. The surface of a still water is a truly level surface. Any surface parallel to the mean spheroidal surface of the earth is, therefore, a level surface.

c) Define horizontal plane
Ans: Horizontal plane: Horizontal plane through a point is a plane tangential to the level surface at that point. It is, therefore, perpendicular to the plumb line through the point.

d) Define Horizontal line
Ans: Horizontal line: It is a straight line tangential to the level line at a point. It is also perpendicular to the plumb line.

e) Define vertical line
Ans: Vertical line: It is a line normal to the level line at a point. It is commonly considered to be the line defined by a plumb line.

2. Three marks question with answers

a) What are the checks in Rise and Fall method
Ans: In case of Rise and Fall method for Reduction of level, following arithmetic checks are applied to verify calculations.

\[ S\text{ B.S.} - S\text{ F.S.} = S\text{ Rise} - S\text{ Fall} = \text{Last R.L.} - \text{First R.L} \]

b) **Define line of collimation**

Ans: Line of collimation: Line joining the intersection of the cross-hairs to the optical center of the objective and its continuation. It is also known as Line of sight.

c) **What is contour interval**

Ans: The contour interval of a contour map is the difference in elevation between successive contour lines.

d) **Define contours**

Ans: A contour line of a function of two variables is a curve along which the function has a constant value, so that the curve joins points of equal value. It is a plane section of the three-dimensional graph of the function \( f(x, y) \) parallel to the \( x, y \) plane. In cartography, a contour line (often just called a "contour") joins points of equal elevation (height) above a given level, such as mean sea level. A contour map is a map illustrated with contour lines, for example a topographic map, which thus shows valleys and hills, and the steepness or gentleness of slopes. The contour interval of a contour map is the difference in elevation between successive contour lines.

e) **Define contour Gradient.**

Ans: An imaginary line on the surface of the earth having a constant inclination with the horizontal (slope) is called contour gradient. The inclination of a contour gradient is generally given either as rising gradient or falling gradient, and is expressed as ratio of the vertical height to a specified horizontal distance.

3. Five marks question with answers

a) Explain briefly about the different types of leveling instruments

b) Write the temporary adjustments of a level.

Ans: Temporary Adjustment The temporary adjustments are made at each set up of the instrument before we start taking observations with the instrument. There are three temporary adjustments of a theodolite:
i) Centering.
ii) Levelling.
iii) Focussing.

c) Classify the different type of errors in leveling.

Ans: There are following types of Errors in Leveling :-

1. Instrumental Errors
2. Collimation Error
3. Error due to Curvature & Refraction
4. Other Errors

1. **Instrumental error and Correction**

1. Collimation error
   o **Correction**: Check before use and equalise sights.
3. Errors in staff graduation
   o **Correction**: Check
4. Loose tripod head.
5. Telescope not parallel to bubble tube
   o **Correction**: Permanent adjustment.
6. Telescope not at right angles to the vertical axis
   o **Correction**: Permanent adjustment

2. **Error of Collimation**

Collimation error occurs when the collimation axis is not truly horizontal when the instrument is level. The effect is illustrated in the sketch below, where the collimation axis is tilted with respect to the horizontal by an angle $\alpha$. 
3. Curvature & Refraction

Curvature of the earth:

The earth appears to “fall away” with distance. The curved shape of the earth means that the level surface through the telescope will depart from the horizontal plane through the telescope as the line of sight proceeds to the horizon.

This effect makes actual level rod readings too large by:

\[ C = 0.0239D^2 \]

where \( D \) is the sight distance in thousands of feet.

Effects of Curvature are:

- Rod reading is too high
- Error increases exponentially with distance

Atmospheric Refraction:

Refraction is largely a function of atmospheric pressure and temperature gradients, which may cause:

the bending to be up or down by extremely variable amounts.

There are basically three types of temperature gradient (dT/dh):

1. **Absorption**: occurs mainly at night when the colder ground absorbs heat from the atmosphere.
This causes the atmospheric temperature to increase with distance from the ground and $\frac{dT}{dh} > 0$.

2. **Emission**: occurs mainly during the day when the warmer ground emits heat into the atmosphere, resulting in a negative temperature gradient, i.e. $\frac{dT}{dh} < 0$.

3. **Equilibrium**: no heat transfer takes place ($dT/dh = 0$) and occurs only briefly in the evening and morning.

4. The result of $dT/dh < 0$ is to cause the light ray to be convex to the ground rather than concave as generally shown.

   - This effect increases the closer to the ground the light ray gets and errors in the region of 5 mm/km have resulted.

   The atmosphere refracts the horizontal line of sight downward, making the level rod reading smaller. The typical effect of refraction is equal to about 14% of the effect of earth curvature.

**Combined Effect of Curvature and Refraction in Survey**

The combined effect of curvature and refraction is approximately

$$(C - r) = 0.0206D^2$$

The formula for computing the combined effect of curvature and refraction is:

$$C + R = 0.021K^2$$

Where $C = \text{correction for curvature}$
R = correction for refraction

K = sighting distance in thousands of feet

**Correlations for various distances**

<table>
<thead>
<tr>
<th>Distance</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>100’</td>
<td>0.00021’</td>
</tr>
<tr>
<td>200’</td>
<td>0.00082’</td>
</tr>
<tr>
<td>500’</td>
<td>0.0052’</td>
</tr>
<tr>
<td>700’</td>
<td>0.01’</td>
</tr>
<tr>
<td>1 mile</td>
<td>0.574’</td>
</tr>
</tbody>
</table>

**How to eliminate error due to Curvature and Refraction**

1. Proper field procedures (taking shorter shots and balancing shots) can practically reduce errors
2. Wherever possible, staff readings should be kept at least 0.5 m above the ground,
3. Using short observation distances (25 m) equalized for backsight and foresight
4. Air below is denser than air above Air below is denser than air above, Line of sight is bent downward which Negate s earth curvature error by 14%.
5. Simultaneous Reciprocal Trigonometrical Heightening
6. Observations made at each station at exactly the same time, cancels the effects of curvature and refraction

**4. Other sources of errors in levelling and their correction:**

<table>
<thead>
<tr>
<th>Type of Error</th>
<th>Correction</th>
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</table>

1. Incorrect setting-up of instrument.

2. Movement of staff from position when changing level station.  
   - Training the staff men
   - Experienced/Skilled Staffmen

3. Staff not held vertically.  
   - Hold rod firmly; Use head/body to support it.

4. **Parallax**: Instrument knocked or moved during backsight-foresight reading  
   - Adjust parallax error if any

5. Ground heating causes chaotic refraction of light  
   - Shorten the length of shots
   - Keep measurement 2-3 ft above ground
   - Avoid leveling during noon hours

6. Tripod or rod settles between measurements e.g Bubble off center  
   - Quick measurements between rods
   - Avoid muddy or thawing ground
   - Avoid hot asphalt
   - Don’t exert pressure on turning point

d) The following staff readings were observed successively with a level, the instrument having been moved after third, sixth and eight readings 2.228, 1.606, 0.988, 2.090, 2.864, 1.262, 0.602, 1.982, 1.044, 2.684 meters. Enter the above readings in a page of a level book and calculate the R L of points if the first reading was taken with a staff held on a bench mark of 432.384m
e) The following ten readings were taken with a level, the instrument being shifted after the fifth and eighth readings: 1.315, 0.965, 1.345, 1.105, 0.875, 1.155, 1.305, 1.675, 1.345 and 1.875. The RL of the first turning point is 100.000. Find the reduced levels of the remaining points by the Rise and fall method.

UNIT – III

1. Two marks question with answers

a) Define the terms i) transit theodolite ii) Non-transit theodolite iii) vertical axis iv) horizontal axis.
Ans: A theodolite is a precision instrument for measuring angles in the horizontal and vertical planes. Theodolites are used mainly for surveying applications, and have been adapted for specialized purposes such as meteorology and rocket launch.

A modern theodolite consists of a movable telescope mounted within two perpendicular axes: the horizontal or trunnion axis and the zenith axis. A theodolite measures vertical angles as angles between the zenith, forwards or plunged—typically approximately 90 and 270 degrees. When the telescope is pointed at a target object, the angle of each of these axes can be measured with great precision, typically to mill radian or seconds of arc.

A theodolite may be either transit or non-transit. In a transit theodolite, the telescope can be inverted in the vertical plane, whereas the rotation in the same plane is restricted to a semi-circle in a non-transit theodolite. Some types of transit theodolites do not allow the measurement of vertical angles.

b) Define the terms i) transiting ii) swinging of telescope iii) face left observation iv) face right observation.
Ans: Transiting:
A surveying instrument for measuring horizontal and vertical angles, consisting of a small telescope mounted on a tripod.

Swinging of telescope
It means turning the telescope about its vertical axis in the horizontal plane.
A swing is called right or left according as the telescope is rotated clockwise or counter clockwise.
**Face Left Observation**
If the vertical circle of the instrument is on the left side of the observer while taking a reading, the position is called the face left and the observation taken on the horizontal or vertical circle in this position, is known as the face left observation.

**Face Right Observation**
If the vertical circle of the instrument is on the right side of the observer while taking a reading, the position is called the face right and the observation taken on the horizontal or vertical circle in this position, is known as the face right observation.

c) **What is a tie line**
Ans: Tie line: a tie line is a line which joins subsidiary or tie stations to the main line. The main object of running a tie line is to take the details of nearby objects but it also serves the purpose of a check line.

d) **What is a Base line**
Ans: Base line: It is the most important line & is the longest line. Main frame works of survey line are built on it.

e) **What is a check line**
Ans: Check lines: These are the lines connecting Main station to a subsidiary station on opposite site are connecting to subsidiary station. On the sides of main lines the purpose measuring such lines is to check the accuracy within main station are located this lines are also known as group line.

1. **Three marks question with answers**
a) **Define the terms** i) transit theodolite ii) Non-transit theodolite iii) vertical axis iv) horizontal axis.
Ans: A theodolite is a precision instrument for measuring angles in the horizontal and vertical planes. Theodolites are used mainly for surveying applications, and have been adapted for specialized purposes such as meteorology and rocket launch.

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A theodolite may be either transit or non-transit. In a transit theodolite, the telescope can be inverted in the vertical plane, whereas the rotation in the same plane is restricted to a semi-circle in a non-transit theodolite. Some types of transit theodolites do not allow the measurement of vertical angles.

**Vertical Axis**

It is the axis about which the telescope can be rotated in the horizontal plane.

**Horizontal Axis**

It is the axis about which the telescope can be rotated in the vertical plane. It is also called the trunion axis.

b) Define the terms i) transiting ii) swinging of telescope iii) face left observation iv) face right observation

Ans: **Transiting:**

A surveying instrument for measuring horizontal and vertical angles, consisting of a small telescope mounted on a tripod.

**Swinging of telescope**

It means turning the telescope about its vertical axis in the horizontal plane.

A swing is called right or left according as the telescope is rotated clockwise or counter clockwise.

**Face Left Observation**

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**Face Right Observation**

If the vertical circle of the instrument is on the right side of the observer while taking a reading, the position is called the face right and the observation taken on the horizontal or vertical circle in this position, is known as the face right observation.

c) **Write the formula for an area using mid-ordinate rule.**

Ans: Mid Ordinate Rule: According to the rule, the base line AB of irregular figure ABCD is divided into a number of equal strips each of breadth s. At the midpoint of each strip a vertical line drawn is called the mid ordinate. Let, a, b, c, d, e, f be the lengths of these and ordinates. The area of each strip is approximately equal to s x mid ordinate.

Approximate area of the figure ABCD = S \((a + b + c + d + e + f)\)
Where $S =$ breadth of each strip.
If the figure is divided into a different of strips, then area of the figure = $S(a + b + c + d + \ldots)$

d) Write the formula for an area using average ordinate rule

e) Write the formula for an area using trapezoidal rule

Ans: Trapezoidal Rule: The trapezoidal rule is another method for finding the area of irregular plane figures. Let ABCD be an irregular figure. To find the area of figure ABCD, divide the figure into a number of strip of equal width. Each strip is treated as trapezium. So the area of the figure ABCD is the sum of the areas of all these trapeziums. Let $s$ be the width of each strip and $a, b, c, d, \ldots$ be the ordinates of the sides of the strips.

Thus, Area = $S[\text{Sum of first and last ordinate} + 2 \times (\text{Sum of remaining ordinates})]$  
Area = $S[\frac{a + b}{2} = (a + d + e + f + g)]$

2. Five marks question with answers

a) Discuss the following methods of computation of area of a tract with straight but irregular boundaries. i) Mid-ordinate rule ii) Average - ordinate rule iii) Trapezoidal rule.

b) The following perpendicular offsets were taken at 10m intervals from a survey line to an irregular boundary line 3.25, 5.60, 4.20, 6.65, 8.75, 6.20, 3.25, 4.20, 5.65 calculate the area enclosed between the survey line, the irregular boundary line, and the first and last offsets, by the application of i) Trapezoidal rule ii) Simpson’s rule.

c) A series of offsets were taken from a chain line to a curved boundary line at intervals of 15m in the following order 0.2, 65, 3.80, 3.75, 4.65, 3.60, 4.95, 5.85m compute the area between the chain line, the curved boundary line and the end offsets by i) Trapezoidal rule ii) Simpsons rule.

d) A railway embankment is 10m wide with side slope 1.5 to 1 assume the ground to be level in a direction traverse to the centre line, calculate the volume contained in a length of 120m, the centre height at 20m intervals being in meters 1.2, 4.7, 3.8, 4.0, 1.8, 2.8, 2.5 solve using Prismoidal rule.

e) A railway embankment is 10m wide with side slope 1.5 to 1 assume the ground to be level in a direction traverse to the centre line, calculate the volume contained in a length of 120m, the centre height at 20m intervals being in meters 2.2, 3.7, 3.8, 2.0, 3.8, 3.8, 2.5 solve using Trapezoidal rule.
UNIT – IV

1. Two marks question with answers

a) Define transit theodolite
Ans: A theodolite is a precision instrument for measuring angles in the horizontal and vertical planes. Theodolites are used mainly for surveying applications, and have been adapted for specialized purposes such as meteorology and rocket launch.

A modern theodolite consists of a movable telescope mounted within two perpendicular axes: the horizontal or trunnion axis and the zenith axis. A theodolite measures vertical angles as angles between the zenith, forwards or plunged—typically approximately 90 and 270 degrees. When the telescope is pointed at a target object, the angle of each of these axes can be measured with great precision, typically to mill radian or seconds of arc.

b) Define Non-transit theodolite
Ans: A theodolite may be either transit or non-transit. In a transit theodolite, the telescope can be inverted in the vertical plane, whereas the rotation in the same plane is restricted to a semi-circle in a non-transit theodolite. Some types of transit theodolites do not allow the measurement of vertical angles.

c) Define vertical axis
Ans: Vertical Axis
It is the axis about which the telescope can be rotated in the horizontal plane.

d) Define horizontal axis
Ans: Horizontal Axis
It is the axis about which the telescope can be rotated in the vertical plane. It is also called the trunion axis.

e) Define line of sight or line of collimation
Ans: Line of collimation: Line joining the intersection of the cross-hairs to the optical center of the objective and its continuation. It is also known as Line of sight.

1. Three marks question with answers

a) Define line of sight or line of collimation
Ans: Line of collimation: Line joining the intersection of the cross-hairs to the optical center of the objective and its continuation. It is also known as Line of sight.
b) Define transiting
Ans: **Transiting:**
A surveying instrument for measuring horizontal and vertical angles, consisting of a small telescope mounted on a tripod.

c) Define swinging of telescope
Ans: **Swinging of telescope**
It means turning the telescope about its vertical axis in the horizontal plane.
A swing is called right or left according as the telescope is rotated clockwise or counter clockwise.

d) Define vertical circle of a telescope
Ans: **Vertical Circle**
Vertical circle is fitted to telescope and moves simultaneously with telescope. It has graduation in each quadrant numbered from 0 to 90 degrees.

e) Define trigonometric leveling
Ans: **Trigonometric levelling**
Trigonometric levelling is the process of determining the differences of elevations of stations from observed vertical angles and known distances.

3. Five marks question with answers

a) Explain the temporary adjustments of theodolite.
Ans: Temporary Adjustment The temporary adjustments are made at each set up of the instrument before we start taking observations with the instrument. There are three temporary adjustments of a theodolite:

   i. Centering.
   ii. Levelling.
   iii. Focussing.

b) Explain the procedure for the reiteration method of measuring horizontal angles.
Ans: To measure the horizontal angles between the given stations about the instrument station as the vertex by the method of reiteration.

Instruments and Accessories Required:
Theodolite, Pegs, Arrows, Ranging rod, etc.
Procedure:
1. The theodolite is mounted on the tripod stand.
2. The theodolite is centered over an arbitrarily selected station P from where the given stations can be sighted without any obstruction and the instrument is levelled using the foot screws and the plate bubble is brought to the centre of the run.
3. The theodolite is set on the face right mode on the vernier A and the horizontal circle is initially set at 0°00’00” and the station A is sighted.
4. The upper clamp screw is unclamped and the theodolite is swung to the right and the stations B,C,D and A are sighted in sequence and the central vertical cross hair is made to bisect these stations and the horizontal angles on both the vernier A and B are observed and recorded. The observations are closed on the first station A.
5. The theodolite is then set on the face left mode and the vernier A on the horizontal circle is initially set at 180°00’00” and the station A is sighted.
6. The upper clamp screw is unclamped and the theodolite is swung to the left and the stations D,C,B and A are sighted in sequence and the central vertical cross hair is made to bisect these stations and the horizontal angles on both the vernier A and B are observed and recorded. The observations are closed on the first station A.
7. The observations are recorded in the field book.
8. The mean values of the horizontal angles on vernier A and B are computed for every sighting and the horizontal included angles are determined as the difference in successive mean values.
9. The average of the two sets of horizontal included angles observed one set each for the two initial settings of vernier A is determined as the result.
Tabulation

<table>
<thead>
<tr>
<th>Inst Sighted to</th>
<th>Horizontal Circle Reading</th>
<th>Included Angle</th>
<th>Average Included Angle</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACE RIGHT</td>
<td>A</td>
<td></td>
<td></td>
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<td>P</td>
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</tbody>
</table>

Result: The horizontal angles between the given stations about the instrument station as the vertex are determined by the method of reiteration

i. Angle APB =

ii. Angle BPC =

iii. Angle CPD =

iv. Angle DPA =

c) Explain briefly the possible instrumental errors in theodolite work and the precautions that should be taken to eliminate them.

d) Define triangulation method in detail

ans: Triangulation is the process of determining the location of a point by measuring only angles to it from known points at either end of a fixed baseline, rather than measuring distances to the point directly as in trilateration. The point can then be fixed as the third point of a triangle with one known side and two known angles.

Triangulation can also refer to the accurate surveying of systems of very large triangles, called triangulation networks.

By applying trigonometry and the measured length of just one side, the other distances in the triangle are measured. The shape of the triangles is very crucial as there may be several errors in a long skinny triangle, but one having base angles of about 45 degrees is perfect.
Each of the distances already calculated is then applied as one side in another triangle to work out the distances to another point, which sequentially can set up another triangle.

As needed, it is performed frequently to develop a chain of triangles which connect the origin point to the Survey Control in the required place.

The angles and distances are then applied with the preliminary identified position, and complicated formulae, to calculate the position (Latitude and Longitude) of all other points in the triangulation network.

The calculated distance in the first triangle is called as the ‘Baseline’ and is the only distance measured; all the rest are computed from it and the measured angles.

e) What is mean by face left and face right of theodolite? How would you change face? What instrumental errors are eliminated by face left and face right observations?

UNIT – IV
1. Two marks question with answers

a) Write a short notes on GPS.
Ans: GPS (Global Positioning System) is a satellite-based navigation system which was created by U.S. Department of Defence as a part of NAVSTAR satellite program. It gives geolocation and time information to a GPS receiver in all climate conditions, anywhere on or close to the Earth where there is an unobstructed line of sight to four or more GPS satellites.

GPS has three segments:
1. Space segment
2. Control segment
3. User segment

b) Write short notes on GIS.
Ans: A “geographic information system” (GIS) is a computer-based tool that allows you to create, manipulate, analyze, store and display information based on its location. GIS makes it possible to integrate different kinds of geographic information, such as digital maps, aerial photographs, satellite images and global positioning system data (GPS), along with associated tabular database information (e.g., 'attributes' or characteristics about geographic features).
c) State the advantages of GPS.
Ans: Advantages of GPS:

- GPS is extremely easy to navigate as it tells you to the direction for each turns you take or you have to take to reach to your destination.
- GPS works in all weather so you need not to worry of the climate as in other navigating devices.
- The GPS costs you very low in comparison other navigation systems.
- The most attractive feature of this system is its 100% coverage on the planet. It also helps you to search the nearby restaurants, hotels and gas stations and is very useful for a new place.
- Due to its low cost, it is very easy to integrate into other technologies like cell phone.
- The system is updated regularly by the US government and hence is very advance.
- This is the best navigating system in water as in larger water bodies we are often misled due to lack of proper directions.

2. Three marks question with answers

a) Write a brief notes on GPS.
Ans: GPS (Global Positioning System) is a satellite-based navigation system which was created by U.S. Department of Defence as a part of NAVSTAR satellite program. It gives geo location and time information to a GPS receiver in all climate conditions, anywhere on or close to the Earth where there is an unobstructed line of sight to four or more GPS satellites.

GPS has three segments:
1. Space segment
2. Control segment
3. User segment

The space segment is made up of at least 24 satellites with are placed on six circular orbital planes (Four satellites per one orbit). Each orbit is inclined at an angle of 55° relative to equator plus they are separated by 60°. Satellites are at an altitude of approximately 20,200km (12,600 mi).

As of 2016, there are actually thirty-two satellites in the GPS constellation, thirty-one of which are in use. Every satellite requires 11 hours and 56 minutes to circle the earth. The extra satellites enhance the accuracy of GPS receiver calculations by giving redundant
measurements. Considering the increased number of satellites, the constellation was changed to a non uniform set up.

The control segment handles synchronizing satellite’s atomic clocks and adjusts the ephemeris of each and every satellite’s inner orbital model. It is maintained by U.S. Air Force.

User segment is for typical users (like civil, commercial, scientific, military users, etc.) that want to make use of GPS receivers to estimate their position.

b) Write brief notes on GIS.

Ans: A “geographic information system” (GIS) is a computer-based tool that allows you to create, manipulate, analyze, store and display information based on its location. GIS makes it possible to integrate different kinds of geographic information, such as digital maps, aerial photographs, satellite images and global positioning system data (GPS), along with associated tabular database information (e.g., ‘attributes' or characteristics about geographic features).

c) State the advantages and disadvantages of GPS.

Ans: Advantages of GPS:

- GPS is extremely easy to navigate as it tells you to the direction for each turns you take or you have to take to reach to your destination.
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- It also helps you to search the nearby restaurants, hotels and gas stations and is very useful for a new place.
- Due to its low cost, it is very easy to integrate into other technologies like cell phone.
- The system is updated regularly by the US government and hence is very advance.
- This is the best navigating system in water as in larger water bodies we are often misled due to lack of proper directions.

Disadvantages of Global Positioning System

- Sometimes the GPS may fail due to certain reasons and in that case you need to carry a backup map and directions.
If you are using GPS on a battery operated device, there may be a battery failure and you may need a external power supply which is not always possible.

Sometimes the GPS signals are not accurate due to some obstacles to the signals such as buildings, trees and sometimes by extreme atmospheric conditions such as geomagnetic storms.

d) What are the applications in advanced surveying.

Ans:

4. Five marks question with answers

a) Write briefly about the applications of GIS.

Ans: GIS applications

Uses of GIS range from indigenous people, communities, research institutions, environmental scientists, health organizations, land use planners, businesses, and government agencies at all levels.

Some examples include:

- Crime mapping
- Economic development and investment promotion
- Historical geographic information systems
- GIS and hydrology
- Remote sensing applications
- Traditional knowledge GIS
- Public Participation GIS
- Road networking
- Wastewater and storm water systems
- Waste management

b) What are the merits and demerits of total station.

Ans: ADVANTAGES OF TOTAL STATION:

1. Quick setup of the instrument on the tripod by utilizing the laser plummets.
2. Programmed with on board area computation for computing the area of a field.

3. It supports local languages.

4. It shows the graphical view of land and plots.

5. No recording and writing errors.

6. It gives more accurate measurements than other conventional surveying instruments.

7. Data can be saved and transferred to a PC.

8. It has integrated database.


10. All in one and multitasking instrument, from surveying to GIS creation by using the appropriate software.

11. Faster work, saves time, quick finishing off the job.

**DISADVANTAGES OF TOTAL STATION:**

1. The instrument is costlier than other conventional surveying instruments.

2. It might be troublesome for the surveyor to investigate and check the work when surveying.

3. Working with total station is not so easy, as more skilled surveyors are required to conduct a total station survey.

4. To check the survey work thoroughly it would be necessary to come back to the office and prepare the drawings by using the right software.

c) **Describe briefly the advantages of total station.**

**Ans: ADVANTAGES OF TOTAL STATION:**

1. Quick setup of the instrument on the tripod by utilizing the laser plummet.

2. Programmed with on board area computation for computing the area of a field.

3. It supports local languages.

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Unit V

Photographic surveying

Photogrammetry consists two branches:

1. Terrestrial photogrammetric
2. Aerial photogrammetric

In terrestrial photogrammetric photographs are taken from a fixed position on ground while in the aerial photogrammetric, an aircraft with camera setup is used to take photographs from the air flying over the ground. In this article we will discuss about the aerial photography.

When aerial camera captures a photo of ground, the optical axis of camera will intersect at some point (center) in the aerial photograph. This point of intersection is called as principal plane.

Photo Interpretation and Stereoscopy
Photo interpretation is done by the instrument called stereoscope which contains magnifiers. So, one can observe the three-dimensional model of area through it and it also ease the drawing of maps of photographed area. For accuracy, control stations, elevations, length of lines should be sufficiently available.

So, we can say photo interpretation will enable the significance of objects in photograph. Coming to stereoscopes, there are four types of stereoscopes are available which are used for the photo interpretation.

They are namely

- Lens stereoscope
- Mirror stereoscope
- Scanning mirror stereoscope
Zoom stereoscope

Lens and mirror stereoscopes are majorly used for photo interpretation. Apart from these, some characteristics should be maintained for good photo interpretation. The characteristics should be as follows.

- Shape
- Size
- Pattern
- Shadow
- Texture
- Site

**Shape**

Shape is an important property for an object in photograph. The outline or configuration will deliver the shape of an object. So, one can easily recognize from the shape of an object in the map or photograph.

Size is also an important factor in photo interpretation. The size should fixed to some scale and properly interpreted on the photograph. Then only the observer can feel the difference between large objects and small objects. For example size of major river and drain should be interpreted in different sizes.

**Pattern**

The arrangement of objects in the photograph should be done in a good pattern in such a way that they should be easily recognizable without any overlapping confusion.

Site is nothing but location of an object. The location of an object can be easily identified based on its surroundings.

**Parallax and Measurement of Parallax**

An aerial photograph can be studied to get the location of an object by its co-ordinates in the photograph.

Similarly, to know the third dimension of same object, there should be minimum of two points of observation is needed from different angles.

Parallax is nothing but a displacement of an object in the photograph when point of observation is shifted to another angle.
In general Measurement of parallax can be done by two ways as follows:

- Floating marks
- Parallax bar

**Aerial triangulation** has witnessed a phenomenal development since its advent about half a century ago. It is probably true that no other single technological innovation has undergone so much change within so short a time. Although aero triangulation methods can be classified into three major categories there are no less than thirty variations of these methods.

These variations constitute an expression of adaptability to the following factors: (i) availability and limitation of current instrumentations (ii) economic considerations (iii) preference for a particular methodological approach (iv) limitations imposed by computational (computer) facilities as well as computational (programming) abilities and (v) accuracy and application requirements. It is the objective of this paper to review various aspects of photo triangulation methods and their applications in surveying and mapping.

**Radial Triangulation**

A graphical method in which directions from radial centre of each overlapping photos are used for resection (to determine planimetric cords of exposure station and intersection (to determine planimetric coords of new prints).

Mosaic mapping

Mosaic mapping is leading edge technology, to provide our customers with the information they require for effective planning and decision making. the geospatial information we provide is customized to meet customer specific requirements.

Mosaic mapping provides geographic information solution to a diverse clientele in local government and the private sector. markets include

- Agriculture
- Asset management
- Resource management
- Construction and forestry
Objective question with answers

1. To avoid large centering error with very short legs, observations are generally made
   (A) To chain pins
   (B) By using optical system for centering the theodolite
   (C) To a target fixed on theodolite tripod on which theodolite may be fitted easily
   (D) All the above

2. Different grades are joined together by a
   (A) Compound curve
   (B) Transition curve
   (C) Reverse curve
   (D) Vertical curve

3. Which of the following methods of theodolite traversing is suitable for locating the
details which are far away from transit stations?
   (A) Measuring angle and distance from one transit station
   (B) Measuring angles to the point from at least two stations
   (C) Measuring angle at one station and distance from other
   (D) Measuring distance from two points on traverse line

4. The line of collimation method of reduction of levels, does not provide a check on
   (A) Intermediate sights
   (B) Fore sights
   (C) Back sights
   (D) Reduced levels

5. Which of the following methods of contouring is most suitable for a hilly terrain?
6. The chord of a curve less than peg interval, is known as
   (A) Small chord
   (B) Sub-chord
   (C) Normal chord
   (D) Short chord

7. The size of a plane table is
   (A) 750 mm × 900 mm
   (B) 600 mm × 750 mm
   (C) 450 mm × 600 mm
   (D) 300 mm × 450 mm

8. If the reduced bearing of a line AB is N60°W and length is 100 m, then the latitude and departure respectively of the line AB will be
   (A) +50 m, +86.6 m
   (B) +86.6 m, -50 m
   (C) +50 m, -86.6 m
   (D) +70.7 m, -50 m

9. A lemniscate curve between the tangents will be transitional throughout if the polar deflection angle of its apex, is
   (A) ∆/2
   (B) ∆/3
   (C) ∆/4
   (D) ∆/6

10. Contour interval is
    (A) Inversely proportional to the scale of the map
    (B) Directly proportional to the flatness of ground
    (C) Larger for accurate works
    (D) Larger if the time available is more

11. Detailed plotting is generally done by
    (A) Radiation
(B) Traversing
(C) Resection
(D) All of the above

12. If the smallest division of a vernier is longer than the smallest division of its primary scale, the vernier is known as

(A) Direct vernier
(B) Double vernier
(C) Retrograde vernier
(D) Simple vernier

13. The method of reversal

(A) Is usually directed to examine whether a certain part is truly parallel or perpendicular to another
(B) Makes the erroneous relationship between parts evident
(C) Both (a) and (b)
(D) Neither (a) nor (b)

14. The line normal to the plumb line is known as

(A) Horizontal line
(B) Level line
(C) Datum line
(D) Vertical line

15. In levelling operation

(A) When the instrument is being shifted, the staff must not be moved
(B) When the staff is being carried forward, the instrument must remain stationary
(C) Both (a) and (b)
(D) Neither (a) nor (b)

16. The two point problem and three point problem are methods of

(A) Resection
(B) Orientation
(C) Traversing
(D) Resection and orientation

17. Ramsden eye-piece consists of

(A) Two convex lenses short distance apart
(B) Two concave lenses short distance apart
(C) One convex lens and one concave lens short distance apart
(D) Two Plano-convex lenses short distance apart, with the convex surfaces facing each other

18. The line of sight is kept as high above ground surface as possible to minimise the error in the observed angles due to

(A) Shimmering
(B) Horizontal refraction
(C) Vertical refraction
(D) Both shimmering and horizontal refraction

19. If is the stadia distance, is the focal length and is the distance between the objective and vertical axis of the techeometer, the multiplying constant, is

(A) \( f/i \)
(B) \( i/f \)
(C) \( (f + d) \)
(D) \( f/d \)

20. The desired sensitivity of a bubble tube with 2 mm divisions is 30". The radius of the bubble tube should be

(A) 13.75 m
(B) 3.44 m
(C) 1375 m
(D) None of these

21. Subtense bar is an instrument used for

(A) Levelling
(B) Measurement of horizontal distances in plane areas
(C) Measurement of horizontal distances in undulated areas
22. Volume of the earth work may be calculated by

(A) Mean areas
(B) End areas
(C) Trapezoidal
(D) All the above

23. Pick up the correct statement from the following:

(A) The directions of plumb lines suspended at different points in a survey are not strictly parallel
(B) In surveys of small extent, the effect of curvature may be ignored and the level surface of the earth is assumed as horizontal
(C) In surveys of large extent, the effect of curvature of the earth must be considered
(D) All the above

24. In levelling operation

(A) If second reading is more than first, it represents a rise
(B) If first reading is more than second, it represents a rise
(C) If first reading is less than second, it represents a fall
(D) Both (b) and (c)

25. Over-turning of vehicles on a curve can be avoided by using

(A) Compound curve
(B) Vertical curve
(C) Reverse curve
(D) Transition curve

26. Which of the following introduces an error of about 1 in 1000 if 20 m chain is used?

(A) Length of chain 20 mm wrong
(B) One end of the chain 0.9 m off the line
(C) One end of chain 0.9 m higher than the other
(D) All the above
27. Chain surveying is well adopted for

(A) Small areas in open ground
(B) Small areas with crowded details
(C) Large areas with simple details
(D) Large areas with difficult details

28. Two contour lines, having the same elevation

(A) Cannot cross each other
(B) Can cross each other
(C) Cannot unite together
(D) Can unite together

29. Which of the following statements is incorrect?

(A) Error due to refraction may not be completely eliminated by reciprocal levelling
(B) Tilting levels are commonly used for precision work
(C) The last reading of levelling is always a foresight
(D) All of the above statements are incorrect

30. In levelling operation,

(A) The first sight on any change point is a back sight
(B) The second sight on any change point is a fore sight
(C) The line commences with a fore sight and closes with a back sight
(D) The line commences with a back sight and closes with a foresight

31. The length of a traverse leg may be obtained by multiplying the latitude and

(A) Secant of its reduced bearing
(B) Sine of its reduced bearing
(C) Cosine of its reduced bearing
(D) Tangent of its reduced bearing

32. While working on a plane table, the correct rule is:

(A) Draw continuous lines from all instrument stations
(B) Draw short rays sufficient to contain the points sought
33. The vertical angle between longitudinal axis of a freely suspended magnetic needle and a horizontal line at its pivot, is known

(A) Declination  
(B) Azimuth  
(C) Dip  
(D) Bearing

34. In the cross-section method of indirect contouring, the spacing of cross-sections depends upon

(i) Contour interval  
(ii) Scale of plan  
(iii) Characteristics of ground

The correct answer is

(A) Only (i)  
(B) (i) and (ii)  
(C) (ii) and (iii)  
(D) (i), (ii) and (iii)

35. Transition curves are introduced at either end of a circular curve, to obtain

(A) Gradually decrease of curvature from zero at the tangent point to the specified quantity at the junction of the transition curve with main curve  
(B) Gradual increase of super-elevation from zero at the tangent point to the specified amount at the junction of the transition curve with main curve  
(C) Gradual change of gradient from zero at the tangent point to the specified amount at the junction of the transition curve with main curve  
(D) None of these

36. A and B sextant. The correct horizontal angle is

(A) cos - (B) cos - (C) cos - (D) None of these

Tilt of the staff in stadia tacheometry increases the intercept if it is

(A) Away from the telescope pointing down hill
(B) Towards the telescope pointing up-hill

(C) Away from the telescope pointing up-hill

(D) None of these

37. A dumpy level is set up with its eye-piece vertically over a peg. The height from the top of peg to the centre of the eye-piece is 1.540 m and the reading on peg is 0.705 m. The level is then setup over. The height of the eye-piece above peg is 1.490 m and a reading on is 2.195 m. The difference in level between and is

(A) 2.900 m
(B) 3.030 m
(C) 0.770 m
(D) 0.785 m

38. In a lemniscate curve the ratio of the angle between the tangent at the end of the polar ray and the straight, and the angle between the polar ray and the straight, is

(A) 2
(B) 3
(C) 4/3
(D) 3/2

39. A level when set up 25 m from peg A and 50 m from peg B reads 2.847 on a staff held on A and 3.462 on a staff held on B, keeping bubble at its centre while reading. If the reduced levels of A and B are 283.665 m and 284.295 m respectively, the collimation error per 100 m is

(A) 0.015 m
(B) 0.030 m
(C) 0.045 m
(D) 0.060 m

40. Hydrographic surveys deal with the mapping of

(A) Large water bodies
(B) Heavenly bodies
(C) Mountainous region
(D) Canal system
41. Bowditch rule is applied to

(A) An open traverse for graphical adjustment

(B) *A closed traverse for adjustment of closing error*

(C) Determine the effect of local attraction

(D) None of the above

42. Angles to a given pivot station observed from a number of traverse stations when plotted, the lines to the pivot station intersect at a common point

(A) Angular measurements are correct and not the linear measurements

(B) Linear measurements are correct and not the angular measurements

(C) Angular and linear measurements are correct and not the plotting of traverse

(D) *Angular and linear measurements and also plotting of the traverse are correct*

43. Pick up the correct statement from the following:

(A) The horizontal angle between magnetic meridian and true meridian at a place is called magnetic declination or variance of the compass

(B) The imaginary lines which pass through points at which the magnetic declinations are equal at a given time are called isogonic lines

(C) The isogonic lines through places at which the declination is zero are termededagonic lines

(D) *All the above*

44. Straight, parallel and widely spaced contours represent

(A) A steep surface

(B) A flat surface

(C) *An inclined plane surface*

(D) Curved surface

45. The real image of an object formed by the objective must lie

(A) *In the plane of cross hairs*

(B) At the centre of the telescope

(C) At the optical centre of the eye-piece

(D) Anywhere inside the telescope
46. For a tachometer the additive and multiplying constants are respectively

(A) 0 and 100
(B) 100 and 0
(C) 0 and 0
(D) 100 and 100

47. Correct distance obtained by an erroneous chain is:

(A) \(\frac{\text{Erroneous chain length}}{\text{Correct chain length}} \times \text{Observed distance}\)
(B) \(\frac{\text{Correct chain length}}{\text{Erroneous chain length}} \times \text{Observed distance}\)
(C) \(\frac{\text{Correct chain length}}{\text{Observed distance}} \times \text{Erroneous chain length}\)
(D) None of these

48. An imaginary line lying throughout on the surface of the earth and preserving a constant inclination to the horizontal, is called

(A) Contour line
(B) Contour gradient
(C) Level line
(D) Line of gentle scope

49. The constant vertical distance between two adjacent contours, is called

(A) Horizontal interval
(B) Horizontal equivalent
(C) Vertical equivalent
(D) Contour interval

50. If a 30 m chain diverges through a perpendicular distance \(d\) from its correct alignment, the error in length, is

(A) \(\frac{d^2}{60}\) m
(B) \(\frac{d^2}{30}\) m
(C) \(\frac{d^2}{40}\) m
(D) \(\frac{d}{30}\) m

16. Fill in the blanks question with answers
1. The reduced bearing of a line is N 87° W. Its whole circle bearing is 273°.

2. Surveys which are carried out to depict mountains, rivers, water bodies, wooded areas and other cultural details, are known as **topographical surveys**.

3. If \( d \) is the distance between equidistant odd ordinates, the Simpson's rule for the areas, is ________________

4. The total change in level along the line is equal to total back sights __________

5. Total latitude of a point is positive if it lies_______________

6. Magnetic declination at any place _________________

7. The method of finding out the difference in elevation between two points for eliminating the effect of curvature and refraction, is _________________

8. The horizontal angle between true meridian and magnetic meridian, is known **magnetic declination**.

9. Perpendicularity of an offset may be judged by eye, if the length of the offset is 15m.

10. A lemniscate curve will not be transitional throughout, if its deflection angle, is 45°.

11. The sensitivity of a bubble tube can be increased by **Increasing the diameter of the tube**.

12. A standard steel tape of length 30 m and cross-section 15 × 1.0 mm was standardised at 25°C and at 30 kg pull. While measuring a base line at the same temperature, the pull applied was 40 kg. If the modulus of elasticity of steel tape is 2.2 × 10^6 kg/cm², the correction to be applied is -0.000909 m.
13. The properties of autogenous curve for automobiles are given by Bernoulli’s Lemniscate.

14. In chain surveying field work is limited to Linear measurements only.

15. The difference of levels between two stations A and B is to be determined. For best results, the instrument station should be Equidistant from A and B.

16. The curve composed of two arcs of different radii having their centres on the opposite side of the curve, is known A reverse curve.

17. The angle of intersection of a curve is the angle between Back tangent and forward tangent.

18. If is the perimeter D is the closing error in departure, the correction for the departure of a traverse side of length , according to Bowditch rule, is \( D \times \frac{1}{l} \).

19. It is more difficult to obtain good results while measuring horizontal distance by stepping Up-hill.

20. An imaginary line lying throughout on the surface of the earth and preserving a constant inclination to the horizontal, is called Contour gradient.

17. Beyond syllabus Topics with material

18. Result Analysis-Remedial/Corrective Action

19. Record of Tutorial Classes

20. Record of Remedial Classes

21. Record of guest lecturers conducted