

West Bengal State Council of Technical &  
Vocational Education and Skill  
Development  
(Technical Education Division)



Syllabus  
of

Diploma in Survey Engineering [SE]

Part-II (4<sup>th</sup> Semester)

Revised 2022

CURRICULAR STRUCTURE OF DIPLOMA IN SURVEY ENGINEERING													
WEST BENGAL STATE COUNCIL OF TECHNICAL & VOCATIONAL EDUCATION AND SKILL DEVELOPMENT													
TEACHING & EXAMINATION SCHEME FOR DIPLOMA IN ENGINEERING COURSES													
SURVEY ENGINEERING							FOURTH SEMESTER						
SLNO	CODE	COURSE TITLE	CREDIT	CLASS/WK			EXAMINATION SCHEME						
				L	T	P	INTERNAL			ESE	PIA	PEA	TOTAL
						INT	AS/QZ	ATD					
1	SEPC202	Surveying – III	2	2	-	-	20	10	10	60	-	-	100
2	SEPC204	Photogrammetry and Remote Sensing	3	3	-	-	20	10	10	60	-	-	100
3	SEPC206	Mine Surveying	3	3	-	-	20	10	10	60	-	-	100
4	SEPC208	Geodesy and Astronomy	2	2	-	-	20	10	10	60	-	-	100
5	SEPC210	Triangulation & Trilateration	2	2	-	-	20	10	10	60			100
6	SEPE202	Program Elective -I	3	3	-	-	20	10	10	60	-	-	100
7	SEPC212	Computer Aided Drawing and Survey Software	2	-	-	4	-	-	-	-	60	40	100
8	SEPC214	Field Surveying Practice -II	2	-	-	4	--	-	-	--	60	40	100
9	PR202	Minor Project	2	-	-	4	-	-	-	-	60	40	100
TOTAL			21	15	-	12	-	-	-	-	-	-	900

**SEPE1: Any one of the two subjects: 1. Estimating, Costing, Specification and Valuation, 2. Theory of Structures.**

**STUDENT CONTACT HOURS PER WEEK: 27 Hrs.** Theories and Practical Period of **60 Minutes** each.  
**L** – Lecture, **T**– Tutorial, **P** – Practical, **INT**- Internal Assessment, **AS/QZ**– Assignment /Quiz, **ATD**– Attendance, **ESE** – End Semester Exam, **PIA**– Practical Internal Assessment, **PEA**– Practical External Assessment.

Course Code	:	SEPC202
Course Title	:	<b>Surveying-III</b>
Number of Credits	:	2
Pre-requisites	:	Students should have the knowledge of drawing and sketching.
Course Category	:	PC

## Course Objective

- To know how to map the terrain of topographical surface of earth.
- To establish control point both horizontal and vertical.
- To know how to prepare contour map.
- To locate the details to topographical features (natural and artificial both) such as rivers, streams, roads, railways, houses etc.
- To measure depth of water body by sounding for various engineering purposes.
- Measuring the velocity of running water and measure the quantum of water flowing.
- To define shore line and under water features.

## Course Content

### 1. Topographic Surveying

- 1.1. **Introduction.** Topography. Topographical surface, Topographic map. It's constituent, feature, purpose and use. Topographical map of Survey of India (SOI), Scale of Topographic map of SOI. Open series map and Defense Series Map of SOI. Conventional sign of topographic map by SOI.
- 1.2. **General.** Scale of topographic map. Different methods of representing relief. Contour – Necessity, contour interval, factor affecting contour interval, calculation.
- 1.3. **Preparing topographic map.** Establishing horizontal and vertical control. Instruments for this surveying. Locating details. Contouring, characteristics of contouring.
- 1.4. **Contouring.** Controlling point method, Cross profile method, Checker board or grid method, Trace contour method. Direct contouring, Indirect contouring. Trace contour method. Details by Cross-Profile method. Details by controlling pointing method. Details by Checker Board method. Details by Precision. Modern technique of drawing contouring from Total Station, LiDAR data on computer (brief overview)
- 1.5. **Use of contour and topographic map.** Drawing section along a contour line, contour gradient and its use in engineering, alignment of road on contour map, inter-visibility of between two points, reservoir capacity, earth work calculation.

### 2. Hydrographic Surveying

#### 2.1. Tidal theory.

- 2.1.1. Tide theory: Tide generating forces, various type of tide, Characteristics, major harmonic constituents.
- 2.1.2. Tide measurement, setting of coastal and off shore tide gauges. Selection of site for tide gauge.
- 2.1.3. Principle operations and imitation of various types of tide gauges – Visual tide gauges, float actuated, pressure sensitive and automatic tide gauges etc.
- 2.1.4. Definition of tidal terms – Current, Tidal streams, Tidal flow residual motion etc.
- 2.1.5. Selection and Establishments of datum, Recovery and transfer of datum– Datum in estuaries and river. Determination of mean sea level.
- 2.1.6. Basic idea of general tidal flow pattern in estuaries and offshore.
- 2.1.7. Bores, surges, Screeches, Gorging, Tidal Prisms, Tidal pyramid, Tidal Wedge etc.

## 2.2. Electronic Instruments

2.2.1. Principle, Operations, accuracy and limitations of various Positioning systems like GPS & DGPS.

2.2.2. Current Meters with electromagnetic sensors.

2.3. **Marks, Mark Work & Demarcation of Channel & Coast Lining.** Erection, description and recovery of surveying marks. Erection and maintenance of navigational marks, laying of transit mark for navigation. Laying of barrel buoy, mooring and channel buoys. Method of coastal lining, important points for coast lining, necessity of coast lining.

2.4. **Soundings:** Interlines, cross lines, test lines, open lines, leading lines etc. recording, importance for straight line sounding. Line spacing, orientation and planning of sounding lines. Single beam and multi-beam echo sounding. Reduction of soundings. Adjustment for settlement, squat etc. Interpretation of Echo Sounder records, sedimentation

2.5. Calculation of cubic capacity and discharge of a cross section of a river, knowledge of Simpson's rule. Premium organization associated with Hydrographic Surveying in India – Indian Navy, National Institute of Ocean Technology (NIOT), Dredging Corporation of India Limited.

### Suggested learning resources:

- Surveying and Levelling by N. N. Basak, Tata McGraw-Hill.
- Surveying and Levelling Vol-II by Dr. B. C. Punmia, Laxmi Publication.
- Surveying and Levelling by S. K. Duggal, Tata McGraw-Hill.
- Plane Surveying by Alak De, S. Chand & Company Pvt. Ltd. New Delhi.
- Conventional sign for topographical map by Survey of India.
- Hydrography C. D. De Jong (Author) and three others. Publication Delft Univ Pr. *Free printable soft copy available on internet free of cost (vector pdf with font embedded).*
- NPTEL videos Higher Surveying by Prof. Ajay Dashora [video 32 - 35]

**Course outcomes:** After completing this course, student will be able to –

- Prepare topographical maps.
- Use topographical map for various engineering and other purpose
- Prepare of contour maps by different methods.
- Learn measurement of depth of water body.
- Get basic idea how to generate under water terrain mapping.
- Use different hydrographic surveying procedure for various need.
- Able to calculate depth, area, volume, flowing quantum of different water bodies and underwater features.

Course Code	: SEPC204
Course Title	: <b>Photogrammetry &amp; Remote Sensing</b>
Number of Credits	: 3
Pre-requisites	: Knowledge of basic surveying with drawing and sketching.
Course Category	: PC

### **Course Objective –**

- To understand the procedures to be followed in Photogrammetry.
- To grow the skill to understand and calculate necessary information from the aerial survey data.
- To understand the principles of Remote Sensing.
- To know about different techniques involved in Remote Sensing.
- To understand various applications of Photogrammetry and Remote Sensing.

### **Course Content**

#### **1. Photogrammetry**

- 1.1. Scope & importance of photogrammetry surveying, Different types of Photogrammetry, Basics of geometrics, Projection and coordinate systems.
- 1.2. Terrestrial photogrammetry: Principle, Graphical method, Analytical method, Stereo photogrammetry & field work; Elementary idea about photogrammetry surveying, Numerical problems
- 1.3. Aerial photogrammetry: Aerial camera and types, Scale of aerial photographs, Map versus Aerial Photograph, Procedure of Aerial Survey including Ground controls, Flight Planning, overlapping of photograph, Wind effects (Crab and Drift), Area covered by one photograph, number of photographs to cover a given area, Interval between exposures, Air Base, Advantages of Using a GNSS/INS for Aerial Photogrammetry
- 1.4. Elementary ideas of instruments used in aerial surveying such as: (a) Aeroplane (b) Unmanned Aerial Vehicle (UAV) (c) Accessories required for interpretation & plotting.
- 1.5. Terminology used in Aerial photogrammetry: i) Exposure Station, ii) Flying Height, iii) Altitude, iv) Tilt, v) Tip, vi) Perspective centre, vii) Plumb points, viii) Principal points, viii) Isocentres, ix) principal plane, x) Horizontal Trace, xi) plate parallels, Scales of the vertical photograph, Distortion of the vertical photograph, Distortion due to height or, relief, Scale & Distortion of the oblique photograph, Numerical problems.
- 1.6. Photogrammetric process Orientation & Triangulation DTM/DEM generation, Photo-interpretation, Basic photo-interpretation equipment: Stereoscope, Parallax, Difference in elevation by stereoscopic parallaxes, Measurement of parallax, Parallax bar, Numerical problems.
- 1.7. Working up data from the photographs: Plotting the details, Rectification, Fiducial Marks, Mosaic, Photographic Maps, Ortho-photos, Digital Elevation Model, Digital Terrain Model, Digital Surface Model.
- 1.8. Development of photogrammetry, Application of Photogrammetry in Advanced Survey Field, Advantages in Photogrammetry, Errors in Photogrammetry, Limitation of photogrammetry.

#### **2. Remote Sensing.**

- 2.1. Definition and Overview of Remote Sensing, History and Evolution of Remote Sensing, Advantages of Remote sensing, limitation of Remote sensing.
- 2.2. Electro Magnetic Energy and its characteristics, Electromagnetic Spectrum, Transmission Path, Effect of atmosphere on electromagnetic radiation, Atmospheric Windows, Interaction of Electro Magnetic Energy with matter and Earth surface features. Idealised Remote Sensing System.
- 2.3. Types of Remote-Sensing Sensor Systems: i) Framing System, ii) Scanning System, iii) Active System, iv) Passive system. Platforms of Remote Sensing.

- 2.4. Resolution Concept in Remote Sensing: i) Spatial Resolution, ii) Radiometric Resolution, iii) Temporal Resolution, iv) Spectral Resolution
- 2.5. Data Analysis: Data Products and Their Characteristics, Data Pre-processing – Atmospheric, Radiometric, Geometric Corrections.
- 2.6. Digital Image Processing: Pre-processing, Basic features and types of digital images, B/W image display and FCC, Image Enhancement, Image Transformation (Multi-image Manipulation), Image Classification and analysis, Data integration and analysis.
- 2.7. LiDAR Remote Sensing: Fundamental of LiDAR remote sensing, LiDAR Data Processing, LiDAR Data Management and Applications, (Topographic Mapping, Flood inundation analysis, Line-of-sight analysis, Forestry, various types of LiDAR sensors) Terrestrial and Bathymetric Laser Scanner.
- 2.8. Application of Remote Sensing in i) Transportation & Logistics, ii) Mining & Geology, iii) Land use and Land cover analysis, iv) Agriculture, v) Urban Planning and management, vii) Forestry, viii) Hydrology, etc.

### **Suggested learning resources:**

- Surveying and Levelling Vol.- 2 by S. K. Duggal, TATA Mc Graw-Hill
- Surveying Vol.- 3 by Dr. K. R. Arora, Standard Book House
- Advanced Surveying by Satheesh Gopi, R. Sathikumar, N. Madhu, Pearson.
- Surveying and Levelling Vol. 3 by Dr. B. C. Punmia, Laxmi Publication.
- Higher Surveying by Dr. A. M. Chandra, New Age International.
- Remote Sensing and Image interpretation by Lillesand, Kiefer and Chipman, Publisher: Wiley. *Low cost Indian edition available. Also Free printable soft copy available on internet free of cost (vector pdf with font embedded).*
- Elements of Photogrammetry with Application in GIS by Paul Wolf, Bon DeWitt and Benjamin Wilkinson. McGraw Hill publication. *Free printable soft copy available on internet (vector pdf with font embedded).*
- Introductory Digital Image Processing: A Remote Sensing Perspective by John R. Jensen, Publisher : Pearson Education. *Low cost Indian edition available. Free printable soft copy available on internet (raster pdf).*
- LiDAR Remote Sensing and Applications (Remote Sensing Applications Series) by Pinliang Dong, Qi Chen. CRC Press. *Free printable soft copy available (vector pdf with font embedded).*
- NPTEL videos – Higher Surveying by Prof. Ajay Dashora [video 15 -26]
- NPTEL videos – Modern Surveying Techniques by Prof. S.K. Ghosh

**Course outcomes:** After completing this course, student will be able to –

- Understand the procedure of Photogrammetric survey.
- Calculate necessary information from aerial survey data.
- Understand the procedure of Remote Sensing.
- Learn different techniques used in Photogrammetry and Remote Sensing.
- Learn about the application of Photogrammetry and Remote Sensing in advanced survey engineering.

Course Code	: SEPC206
Course Title	: <b>Mine Surveying</b>
Number of Credits	: 3
Pre-requisites	: Knowledge of basic surveying, levelling and engineering drawing.
Course Category	: PC

**Course Objective:** Following are the objectives of this course –

- To understand the procedures to be followed in underground surveying.
- To grow the skill to solve dip, strike and fault related problems.
- To understand the setting out procedure of underground curves in tunnels and solve the related problems.
- To know about reserve, process of correlation and solve the related problems.
- To understand various mining regulations.
- Familiarize with different mining terminologies.

## Course Content

### 1. Mine Surveying

- 1.1. **Dip and Strike Problem.** Types of Dip and derivation of the formula used to connect. True dip, Apparent dip and included angles. Problems on Dip. Borehole surveying, Borehole problems for determining the dip (amount and direction) of seams. Computation of quantity of coal in certain block (between boreholes).
- 1.2. **Fault Problem.** Fault Problem: Different geological disturbances encountered in coal, such as fault, dyke, fold, washout etc. Types of faults, folds. Effects of faults in coal mining. Problems on faults.
- 1.3. **Curve Setting.** Designation of curve. Elements of simple circular curve. Setting out a simple circular curve by- i) Chord and offset method, ii) Chord and angle method. Problems on curves in mining.
- 1.4. **Estimation of Reserves** (only Metalliferous Deposit). Minerals, mineral resources, reserves. Methods of calculation of reserves- i) Contour lines method, ii) Mean arithmetic method, iii) Polygon method, iv) Section method Problems on calculation of average width and grade of an ore body. Purpose and scope of Mine sampling. Sampling method and sampling calculations
- 1.5. **Coal Mines Regulations, 2017.** Some definitions related to mine surveying (Reg.2) such as 2(1)(a), (c), (g), (j), (m), (o), (q), (s), (u), (v), (za) to (zf), (zh), (zr), (zza), (zzb), (zzd) to (zzf), (zzj) to (zzm); Notice of Opening (Reg. Age limit and general qualifications of candidates (Reg.14); Practical experience of candidates for Surveyor's Certificate Examination (Reg.16); Appointment of Surveyors (Reg.34); Duties and responsibilities of Surveyors (Reg.53); Regarding mine plans and sections (Reg. 64 to 70); Manual open cast working (Reg. 105); Mechanised opencast working (Reg. 106); Spoil-bank and dump (Reg. 108) Development work (Reg.111); Depillaring work (Reg.112); Multi-section and contiguous working (Reg.118); Working under railway and roads (Reg.119) and Working near mine boundaries in belowground and opencast mines (Reg 121 to 122).
- 1.6. **Mine Correlation and Shaft Survey.** Definition, Purpose, Different Types of Correlation Survey- Direct Traversing & Wire Suspension Through Shafts (Single Shaft Methods & Double Shafts Methods). Single Shaft Methods: 1) Single Wire in Single Shaft Methods (Precise Magnetic Observation Method, Laser Beam Method, Gyro Theodolite Method), 2) Double Wire in single Shaft Method (Weisbach Triangle Method, Approx. Alignment Method & Weiss Quadrilateral Method). Double shaft method – Single wire in each shaft.
- 1.7. **Notable example of Indian Mines (Coal & Metal) and surveying methods.** Coal Mines- Underground & Open Cast. Underground Coal Mines using Bord & Pillar Method (for small scale production) and Highly Mechanised Methods using Longwall Technology and Continuous Miners (Large Scale Production). Surveying Methods in highest producing U/g Coal Mine in India I.e. Jhanjra Project Colliery (Using both Longwall Technology and Continuous Miners) in Eastern Coalfields Ltd. in West Bengal. Underground metal mines– Jadugoda uranium mines.

- 1.8. **Metalliferous Mines Regulation, 1961.** MMR Act article–38, 52, 60, 61, 106 -107, 164-1b.
- 1.9. **Instrument and Software** – Methods of Surveying in using Open Cast Coal Mines using TS & 3D Laser Scanner and calculation of volumes & preparation of mine plans with the help of softwares like LISCAD, RiSCAN Pro, AutoCAD, SURPAC and DATAMINE (no hand on practice and detailed study). Calculation of reserve. Interpretation of ore body. Making mining plan. Volume calculation and stake survey. Production, development plan and section (yearly). [*Note: No hand on practice on 3D Laser scanner and mining software mentioned above, only just brief overview.*]
- 1.10. **Role of a Surveyor in opening of a mine, some terminologies and related concept.** Locating entries of underground mines in the mining leasehold as per plan and maintaining proposed gradient & direction (in case of Incline & Adit) and maintaining verticality (in case of vertical shaft). Maintaining gradient and direction of Access Trench and Haul Roads in Open Cast Projects. Determination of full dip & its rate and direction of a coal seam from borehole data. Role of a Mine Surveyor during opening of a mine-Preparation of Surface Plan as per provisions of CMR, 2017 and MMR, 1961. Notice of opening of a mining, to whole it is served. Assisting in statutory work. Preparing plans for different approvals. Duties and responsibilities of a surveyor in mining. Mining plan and its approval. Functions of Indian Bureau of Mines.
- 1.11. **Knowledge of Geological Terms for a Mine Surveyor and calculation of reserves.** Geological Terms– Full Dip & Apparent Dip of a coal seam, Different types of Faults, Folds, anticline, syncline, washout and Dyke, their effects in mining, Outcrop & incrop of a coal seam, vein or lode. Reserve, resources, resource calculation, minable resources. Exploration. Borehole. Concept of Economical axis, feasibility axis and geological axis– G4, G3, G2 and G1 level of exploration. Mining plan. UNFC code of mineral resources 111, 121 & 122, 334, 221 & 222 etc.

### Suggested learning resources:

- Mine Surveying and Levelling vol-1, 2 & 3 by S Ghatak Coalfield Publisher
- Surveying vol-2 by Dr. K. R. Arora. Standard Book House.
- Plane Surveying by Alak De. S Chand & Company Ltd
- Coal Mines Regulations, 2017 and Metalliferous Mines Regulations, 1961. *Free printable soft copy available in internet.*
- Engineering Surveying by Schofield, W. and Breach M. 6<sup>th</sup> edition. *Free printable soft copy available (vector pdf with font embedded). Low cost special print edition also available in India.*
- Mechanical Excavation in Mining and Civil Industries by Nuh Bilgin (Author), Hanifi Copur (Author), Cemal Balci (Author) Publisher : CRC Press. *Free printable soft copy available.*
- Surface Mining by Kenned B.A. Published by Society for Mining, Metallurgy, and Exploration, Inc. *Free printable soft copy available.*
- Tunnel and Mine Surveying by Sujit Paul. *Free printable soft copy available.*
- A Treatise on Mine-Surveying by Bennett H. Brough, Charles Griffin and Company, London. *Free printable soft copy available (Raster pdf).*
- The Mines Rules 1955 with The Mines Act 1952 (pack of 2 books) by S.N. Raju (Author) Publisher : Planet Publishing House.

**Course outcomes:** After completing this course, student will be able to –

- Understand the procedure of underground survey and solve Dip, Strike and Fault related problems.
- Understand the procedure of setting out underground curves & tunnels and solve the related problems.
- Understand and estimate the underground reserves.
- Learn the procedure of correlation and solve related problems.
- Learn about Mining Regulations.



Course Code	: SEPC208
Course Title	: <b>Geodesy and Astronomy</b>
Number of Credits	: 2
Pre-requisites	: Knowledge of basic surveying.
Course Category	: PC

## Course Objective

Following are the objectives of this course:

- To understand levelling techniques by use trigonometry out of normal levelling process.
- To know basics of astronomy, spherical trigonometry necessary required for a surveyor to calculate true north line and bearing.
- Impart primary ideas of Geodesy.

## Course Content

### 1. Trigonometrical Levelling.

Indirect levelling. Levelling on steep ground. Base of an object accessible. Base of an object inaccessible. Two stations not in the same vertical plane. Curvature and refraction. Axis-signal correction. The difference of elevation by single observation. The difference of elevation by double observation

### 2. Precise Levelling.

Order of precision. Field procedure in geodetic levelling. Correction for collimation, curvature, refraction. Adjustment of level net.

### 3. Astronomy.

3.1. **Basics of astronomy for a surveyor.** Concept of celestial sphere. Astronomical terms. Co-ordinate systems of heavenly bodies (star, sun), Finding co-ordinate of star and sun from Indian Astronomical Ephemeris. Reading a star chart.

3.2. **Spherical trigonometry.** Great circle, small circle, Formula for spherical trigonometry, Area of spherical triangle. Latitude and Longitude.

3.3. **Determination of Azimuth** by Sun and star observation for finding true north bearing, calculation.

4. **Geodesy.** What is Geodesy, Goal of Geodesy, Terminologies– ellipsoid, spheroid, oblate spheroid, Geoid, Equipotential surface, mean sea level, Topographical surface, Geodetic datum, regional geodetic datum, center of earth, global geodetic datum, Geodetic line. Different Ellipsoid and where used (no detailed study) – Everest 1830, Clarke, WGS84. Geometric geodesy, physical geodesy. Satellite geodesy (no detailed study).

## Suggested learning resources:

- Surveying Vol.–2, 3 by Dr. K. R. Arora, Standard Book House
- Surveying and Levelling Part 2 by T. P. Kanetkar & S. V. Kulkarni, Pune Vidhyarthi Griha Prakashan.
- Surveying and Levelling Vol.2, 3 by Dr. B. C. Punmia, Laxmi Publication.
- Surveying and Levelling Vol.2 S. K. Duggal TATA Mc Graw-Hill.
- Indian Astronomical Ephemeris by Positional Astronomy Centre, Kolkata, India Meteorological Department [for finding mean places of stars only]. *Soft copy available on internet free of cost from Positional Astronomy Centre, Kolkata.*
- Star Chart for 12 months. *Soft copy available on internet free of cost from Positional Astronomy Centre, Kolkata.*
- The Surveying Handbook edited by Russell C. Brinker and Roy Minnick. CBS Publication & Distribution Pvt. Ltd. New Delhi.
- Advanced Surveying by P. B. Sahani, Oxford IBH Publishing Co.

- Adjustment of computation by Charles D. Ghilani. 6<sup>th</sup> Edition Wiley publication. *Free printable soft copy available on internet.*

**Course outcomes: After completing this course, student will be able to –**

- Use trigonometrical leveling.
- Understand astronomical survey and application of it to find out true bearing of a survey line.
- Gather knowledge about basics of geodetic surveying.

Course Code	: SEPC210
Course Title	: <b>Triangulation and Trilateration</b>
Number of Credits	: 2
Pre-requisites	: Basic knowledge of surveying.
Course Category	: PC

### Course Objective:

- Know the procedure for reducing error, analyze and adjustment computation of surveying measured data.
- Understanding the method of triangulation surveying to fixed up accurate control points for further surveying.
- To know the method of establishing the accurate control point in long distance.
- To understand the Great Trigonometrical Survey as the basis of national mapping system.
- Understand the methodologies of less costly trilateration to fix up accurate control points with modern electronic distance measuring instrument for subsequent surveying.

### Course Content

1. **Adjustment computation.** Classification of errors. Laws of accidental errors. Most probable values of directly and indirectly observed independent quantities. Weight of observation. Principle of least square. Normal equation. Method of co-relates.
2. **Triangulation.** Brief history Great Trigonometrical Survey (GTS) in India. Classification of triangulation system. Triangulation figures. Triangulation system adopted in India. Strength of figure. Selection of station. Observation of horizontal angles. Base line extension. Stations. Base line measurement. Corrections to the base line. Phase error. Inter-visibility. Satellite station. Different types of application of triangulation survey. Adjustment of different types of triangulation figure by equal shift method only.
3. **Trilateration.** Introduction. Use of Trilateration. Advantage and Disadvantage of Trilateration. Comparison of Trilateration with Triangulation. Geometrical figures used in Trilateration. Reconnaissance in Trilateration. Precision in Trilateration. Reduction of slope distance from vertical angles. Reduction of slope distance from elevations. Adjustment in Trilateration (Adjustment of a Braced Quadrilateral).

### Suggested learning resources:

- Surveying Vol. 2, 3 by Dr. K. R. Arora. Standard Book House.
- Surveying and Levelling Vol. 2 & 3 by Dr. B. C. Punmia Laxmi Publication.
- Surveying and Levelling Vol. 2 by S. K. Duggal. TATA Mc Graw-Hill.
- Higher Surveying by Dr. A. M. Chandra. New Age International publishers.
- Elementary Surveying by Charles D. Ghilani and Paul R. Wolf, Pearson. *Low cost Indian edition available. Free printable soft copy available on internet (vector pdf with font embedded).*
- Adjustment of computation by Charles D. Ghilani. 6th Edition Wiley publication. *Free printable soft copy available on internet (vector pdf with font embedded).*
- NPTEL videos Higher Surveying by Prof. Ajay Dashora [video 9 -13 ]

### Course outcomes:

- Able to use computation technique to get more precise results.
- Understand triangulation survey and application of it.
- Student will get acquainted with the history of Great Trigonometrical Survey.
- Established accurate control points by trilateration survey for use in subsequent precise Engineering surveying and other requirement.

Course Code	: SEPE202 / E-1
Course Title	: <b>Estimating, Costing, Specification and Valuation</b>
Number of Credits	: 3
Pre-requisites	: Nil
Course Category	: PE

## Course Objective

Following are the objectives of this course:

- To learn the procedure for estimating and costing of Civil Engineering works.
- To perform rate analysis for different items associated with construction projects.
- To use software for detailed estimate related to civil infrastructural projects.

## Course Content

### 1. Specification

- 1.1. Definition, importance and manner of writing specification.
- 1.2. Types of specifications. General specification of 1st and 2nd class buildings. Detail specification of important tax items of a building. Foundation of a typical load bearing wall, foundation of a typical isolated RCC column footing, brick work in superstructure, RCC work in slab, beam and column, lime terracing, external and internal plastering, I. P. S. flooring. Woodwork in doors and windows.
- 1.3. Detail specification of important building materials, brick, sand, cement, coarse aggregate, steel reinforcement.
- 1.4. Specification for different types of survey jobs. For a residential building on a plot of size upto 200sq. m. in plain area and hilly area. For a township project of size upto 8 hectares. 1.4.3 For a road project of 3 km. Cadastral surveying of a village.

### 2. Estimation

Different types of estimates, importance of approximate estimate. General items of work for building estimate. Estimating and costing of building from line plan, detail estimate of double storied building as per P.W.D. W.B. schedule of rates or C.P.W.D. Delhi schedule of rates. Mode of measurements based on IS: 1200. Calculation of volume of earthwork by midsection formula, trapezoidal formula or average end area. Principle and example of mass haul diagram. Analysis of rate and how it is prepared. Quantities of material to be analyzed and labour as per labour chart.

### 3. Valuation.

What is valuation? Difference between value and cost. Purpose of valuation. Gross income, net income, scrap value, salvage value. Comparison between scrap value & salvage value. Comparison between market value and book value. Sinking fund, capitalized value, depreciation. Obsolesce, freehold property, lease hold property, mortgage property. Determination of depreciation by different methods.

### 4. Contract.

Definition of tender and contract. Different types of Civil Engineering contracts. Contract documents – List of contract documents. Clauses of general condition of contract. Tender Notice. Comparative statement and acceptance of tender.

## Suggested learning resources:

- Estimating and Costing in Civil engineering by B. N. Dutta, UBS Publishers Distributors Pvt. Ltd.
- Estimating & Costing, Specification and Valuation in Civil Engineering by M. Chakraborti. M. Chakraborti, Calcutta.
- Estimating & costing by S.C. Rangwala. Charotar Publication.
- Civil Engineering contracts and Accounts vol I, II by B.S. Patil. Orient Longman.

- Estimating & Costing by G. S. Birdie. Dhanpat Rai and sons.
- Schedule of Rates Volume –I Building Works, Public Works Department Government of West Bengal. *Pdf copy available free of cost from PWD WB web site.*
- Schedule of Rates Volume –II Sanitary & Plumbing Works, Public Works Department Government of West Bengal. *Pdf copy available free of cost from PWD WB web site.*
- Central Public Works Department Delhi Schedule of Rates Vol I, II. *Pdf copy available free of cost from CPWD web site.*

**Course outcomes:** After completing this course, student will be able to –

- Prepare approximate estimate of a civil engineering works.
- Prepare detailed estimate of a civil engineering works.
- Use relevant software for estimating the quantities and cost of items of works.
- Justify rate for given items of work using rate analysis techniques.

Course Code	: SEPE202 / E-2
Course Title	: <b>Theory of Structures</b>
Number of Credits	: 3
Pre-requisites	: Basic Knowledge of Engineering Mechanics, Mechanics of Material.
Course Category	: PE

## Course Objective

Following are the objectives of this course:

- Understand forces and moments developed in designing of structures
- To learn concept of eccentric loading and stresses in vertical members.
- To analyze beams using various methods like slope deflection, three moments, and moment distribution
- To understand different methods of finding axial forces in trusses.
- Identify the method of analysis for determinate and indeterminate structures
- Understand the importance of various methods of slope and deflections for determinate structures
- Understand the methods of analysis for multistoried frames.
- Understand the effect of wind force on vertical structures like chimneys

## Course Content

1. **Analysis of Structures.** Classification of Structures, Types of structural frameworks and Load transfer Mechanisms, stress resultants, degrees of freedom, Static and Kinematic Indeterminacy for beams, trusses and building frames. Analysis of cables with concentrated and continuous loadings, Static determinacy and indeterminacy.
2. **Propped Cantilever and Fixed Beams.** Determination of static and kinematic indeterminacies for beams- Analysis of Propped cantilever and fixed beams, including the beams with different moments of inertia - subjected to uniformly distributed load - point loads - uniformly varying load, couple and combination of loads - Shear force, bending moment diagrams and elastic curve for Propped Cantilever and Fixed Beams - Deflection of Propped cantilever and fixed beams.
3. **Continuous Beams:** Introduction to Continuous beams - Clapeyron's theorem of three moments, Analysis of continuous beams with constant and variable moments of inertia with one or both ends fixed-continuous beams with overhang.
4. **Principal Stress and Strain.** Stress on inclined planes, principal plane and principal stress in elements subjected to direct and shear stress and their combinations. Mohr Circle for calculation of stress on inclined planes and principal strain for above cases.
5. **Strain Energy and Redundant Frames.** Introduction-Strain energy in linear elastic system, expression of strain energy due to axial load, bending moment and shear forces. Deflections for simple statically determinate beams and frames using Castigliano's theorem, Unit Load Method, Maxwell's reciprocal & Betti's theorem.
6. **Analysis of Multi-Storied Frames.** Moment Distribution Method: Basic proposition relative stiffness, continuous beams with and without fixed ends. (simple problem only) portal method – cantilever method.

## Suggested learning resources:

- Analysis of Structures, Vol- I & II by Ratwani, S.K. Duggal and V.N. Vazirani. Khanna Publishers.
- Theory of Structures by R. S. Khurmi. S. Chand and Co. New Delhi.
- Theory of structures by S. Ramamrutham. Dhanpatrai & Sons.
- Theory of Structures Vol I & II by G S Pandit, S P Gupta and R Gupta. Tata McGraw Hill, New Delhi.

- Basic Structural Analysis by C. S. Reddy. Tata McGraw Hill Education.
- Intermediate Structural Analysis by C. K. Wang. McGraw Hill.
- Theory of Structure by Timoshenko & Young, Tata Mc Grew Hill.

**Course outcomes:** After completing this course, student will be able to –

- Analyze stresses induced in vertical member subjected to direct and bending loads.
- Analyze slope and Deflection in fixed and continuous beams.
- Analyze continuous beam under different loading conditions using the principles of Three Moments.
- Analyze continuous beam using Moment Distribution Method under different loading conditions.
- Evaluate axial forces in the members of simple truss.
- Evaluate forces and moments developed in the designing of structures.
- Identify the method of analysis for determinate and indeterminate structures.
- Apply the various methods for finding out slope and deflections for determinate structures.
- Apply best-suited methods of analysis for multistoried frames.
- Calculate the effect of wind force on vertical structures like chimneys

Course Code	: SEPC212
Course Title	: <b>Computer Aided Drawing and Survey Software</b>
Number of Credits	: 2
Pre-requisites	: Students should have a basic knowledge of computer.
Course Category	: PC

## Course Objective

- Hand-on learning on basics of CAD, spreadsheet, few basics of Civil 3D software.
- Compute necessary survey data from field observation for preparation of drawing etc.
- Familiarize with the names and what can be done with the leading software ruling different field of surveying (no hand-on learning or practice on computer).

## Course Content

### 1. CAD 2D basics

- 1.1. **CAD interface and starting.** Toolbar, menu, command window. Starting a drawing. Commands–new, open, save. Template file acadiso.dwt & acad.dwt for mm and inch. Command–units. Command, command alias and system variable, system variable–filedia.
- 1.2. **Commands.** Drawing command– line, polyline, circle, arc, point, rectangle, polygon, multiline text, single line text. Further practice –Wipeout (for traverse station plotting), dimension, dimension style, block, hatch.
- 1.3. **Editing commands**– erase, copy, offset mirror (system variable mirrtext), move, scale, stretch, trim, extend, fillet, array, rotate, explode Align. List, id, dist area.
- 1.4. **Create and modify**– Layer, line type, line weight, options, polyline edit.
- 1.5. **Drawing aids and tools:** Osnap mode, snap mode, ortho mode, point style (pdmode, ddptype).
- 1.6. **Coordinate entry method**– Cartesian, polar, relative input method. Traverse plot by distance bearing directly.
- 1.7. **The concept behind scaled plotting**– Paper size, scaled output, text height and dimension consideration, margin, 100% black output of colour drawing (monochrome.ctb) without editing, inch mm factor, plotter laser and pdf output.
- 1.8. **Working with raster map and image.** Command–imageattach. Insertion point, scale, rotation.

2. Drawing of Plan, Section, and Elevation of a single storied building using CAD.

3. **Spreadsheet:** Practice with Survey related calculation like computation of independent ordinates from length and bearing, computation of R.L. of target. Points from BS. IS and FS etc. Automated import and export of points, texts, lines, polyline of between CAD and Spreadsheet. Practice of traverse plotting, LS and CS with this automated technique.

4. **AutoCAD Civil 3D.** Contour drawing. Alignment drawing and profile drawing in Civil 3D. (Details steps of such drawings in AutoCAD Civil 3D are mentioned given below. Brief study.)

Fix up proper units and zone in drawing setting in Toolspace tab. Unit: meter. Zone: UTM, WGS84 datum i.e. co-ordinate system. Import survey data, create point groups Create surface with points. Create alignment, add geometric features – curve, spirals. Create surface profile (longitudinal section). Add proper geomatics. Specify proposed cross sectional template with station range (assembly). Make corridor. Sample lines (section lines). Create Multiple section view. Create Mass haul diagram. Generate volume report.



5. **Survey Software** (Excluding hand-on practice on computer. They will only know the name and learn what can be done with these softwares. Brief overview only.) – Mine surveying– Datamine, SURPACK, Hydrographic surveying–HYPACK.

**Suggested learning resources:**

- AutoCAD Instance Reference by George Omura, PBB Publication.
- AutoCAD Command Reference by Autodesk. *Free printable pdf available online.*
- Inbuilt help: Math functions and text function for spreadsheet.
- AutoCAD & Excel tricks for Survey Engineers by Soumen Samanta (YouTube video). Watch from 7:05 to 57:49min. Link: <https://www.youtube.com/watch?v=5hLFaX1gJ8Y>
- Mastering AutoCAD by George Omura. BPB Publication.

**Course outcomes –**

- Able to do CAD drawing independently.
- Calculate, modify and arrange survey data in spreadsheet and feed in CAD automated drawing.
- Prepare contour drawing, alignment drawing, profile drawing easily with less time and without modifying data in Civil 3D.
- He will not be totally unfamiliar with survey software.

Course Code	: SEPC214
Course Title	: Field Surveying Practice - II
Number of Credits	: 2
Pre-requisites	: Drawing and basic knowledge of Surveying
Course Category	: PC

## Course Objective

Following are the objectives of this course:

- Learn to use different survey instruments.
- Record surveying data after field observation with the survey instruments.
- Compute necessary survey data from field observation for preparation of drawing etc.
- Prepare report including drawing using survey data collected in the field.

## Instructions –

Group size for survey practical work should be formed in such a way that each student from a group can handle instruments independently to understand the functions of different components of the instrument.

Drawing and plotting should be considered as part of practical work.

Term work shall consist of record of all practical and projects in field book and drawing of Project work on full/half imperial size drawing sheets

## Course Content

1. **Theodolite Traverse.** Temporary adjustment of Theodolite. Measurement of horizontal angle by repetition method and reiteration method. To traverse by the method of included angles. Individual Traverse: To measure and compute for 5+ sided traverse (for each student).
2. **Trigonometrical Levelling.** To determine height of tower by the theodolite and tape.
3. **Setting Out Curves.** Setting out of simple curve by ordinates or offsets from long chord. Setting out of simple curve by offsets from chords produced. Setting out of simple curve by deflection angles (Rankine's method). Setting out of simple curve by two theodolites method. Method of curve layout when obstruction occurred in curve line.

## Suggested learning resources:

- Surveying Vol. I and II by Dr. K. R. Arora. Standard Book House, Delhi.

**Course outcomes:** After completing this course, student will be able to –

- Perform Theodolite survey
- Measure height of tower
- Calculate survey data required for curve.

Course Code	: PR202
Course Title	: Minor Project
Number of Credits	: 2
Pre-requisites	: Knowledge of basic surveying with drawing.
Course Category	: Project

## Course Objective

Following are the objectives of this course:

- Understand the procedures and different techniques to be followed in various field survey jobs and record the observed data.
- Compute necessary survey data from field observation for preparation of plans, drawings etc.
- Prepare report including drawing using survey data collected in the field.
- Apply knowledge of surveying to read and interpret the basic information from a Topo Sheet.
- Enhance knowledge to represent the surveyed data.

## Course Objective

Group size for minor project work should be formed in such a way that each student from a group can handle instruments and take necessary measurements to understand the working procedure of different survey engineering jobs.

Drawing and plotting should be considered as part of practical work.

All practical data along with necessary drawings are to be submitted as the Minor Project Report by each student.

## Assignment or Practical

1. **Layout of the building.** Building plans are to be assigned by the teacher to the different groups of student)
  - i) **For Load Bearing Structure:** Set out a trench plan of a building. Clearly define the outline of excavation and the center lines of the walls using Centre Line Method.  
Instruments to be used: Chain, Tape, Theodolite, Arrows, Ranging Rods, wooden pegs and other necessary instruments and tools.  
Assignment 1: Draw the trench plan of the building and prepare a report on the procedure to be followed to perform the job.
  - ii) **For Frame Structure:** Clearly define the outline of excavation and the center lines of the positions of columns using Centre Line Method.  
Instrument to be used: Chain, Tape, Theodolite, Arrows, Ranging Rods, wooden pegs and other necessary instruments and tools.  
Assignment 2: Draw the trench plan of the building and prepare a report on the procedure to be followed to perform the job.
2. **Study a Topo Sheet.** Educational sheet with Arbitrary Grid of Survey of India.  
Assignment 3: Prepare a report on the observation of Scales, Map Numbering, Conventional Symbols and basic features of a Survey of India Topo Sheet. Draw the conventional symbols used in the Topo Sheets of Survey of India.
3. **Study the basic features of a contour map.** (contour line diagrams from a topo sheet are to be assigned by the teacher to the different groups of student)  
Assignment 4: Draw topographic profiles from contours of a mountain area with the help of Cross and Longitudinal Profiles. Write the different process used for representation of relief drawing neat sketches of each type.

4. **Cartographic Drawing:** (an introduction to enhance the ability of representation of map information)  
Assignment 5: Graphical construction of scales: Plain, Comparative, Diagonal and Vernier.  
Assignment 6: Prepare bar graph, pie chart and coloured thematic mapping.

**Suggested learning resources:**

- Surveying and Levelling Vol – I by S. K. Duggal, Tata McGraw-Hill.
- Surveying Vol.- I by Dr. K. R. Arora, Standard Book House
- Surveying and Levelling by N. N. Basak, Tata McGraw-Hill.
- Surveying Vol. I and II by Punmia, B. C.
- Fundamentals of Cartography by R. P. Misra. Concept Publishing.

**Course outcomes:** After completing this course, student will be able to –

- Set out the layout of building.
  - Read and interpret a Topo Sheet.
  - Draw topographic profiles from contour diagrams.
  - Draw different bar graphs, pie charts and thematic maps.
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