THEORY OF ERRORS AND ADJUSTMENT

ENGE 304

Lecture : 3 **Year : III**
Tutorial : 0 **Part : I**
Practical : 3

Course Objectives:
The objective of this course is to impart knowledge on errors and adjustment of survey measurements and develop skills in computer programming.

1 Introduction (2 hours)

1.1 Overview of measurements and errors
1.2 Observables and observations
1.3 Significant digit of observations
1.4 Basic matrix operations
1.5 Precision and accuracy
1.6 Accuracy and reliability of networks; Need for adjustment

2 Error Analysis and Propagation (4 hours)

2.1 Error analysis: Systematic, random and gross
2.2 Propagation of errors based on accuracy specification
  2.2.1 Systematic and gross error
  2.2.2 Angle and distance
  2.2.3 Elevation
  2.2.4 Traverse

3 Random Error Theory (3 hours)

3.1 Random error and theory of probability
3.2 Properties of the normal distribution curve
3.3 Standard normal distribution function
3.4 Probability of the standard error and probable error
3.5 Percentage errors and use

4 Mathematical Models (8 hours)

4.1 Observation and stochastic models
4.2 Forms of models
  4.2.1 Direct: Linear, nonlinear, condition model
  4.2.2 Indirect: Parametric-nonlinear, linear

4.2.3 Implicit: Conditions on the observations
4.2.4 Conditions on the unknown parameters

4.3 Combination of models
4.3.1 Conditions on the observations
4.3.2 Conditions on the unknown parameters
4.3.3 ‘Step by step' or 'Sequential' methods

4.4 Solution of models
4.4.1 Linearization of univariate, bivariate and multivariate functions
4.4.2 Taylor series expansion of implicit, parametric and condition models
4.4.3 Linearization of non-linear equations

5 Covariance and Correlation (4 hours)

5.1 Covariance and correlation coefficient matrix of the estimated parameters
5.2 Methods of calculation of correlation coefficients
5.3 Variance-covariance propagations
5.4 Stepwise propagation

6 Least Square Method (12 hours)

6.1 Fundamental of least square adjustments
6.2 Least square adjustment
6.2.1 Implicit model
6.2.2 Parametric model
6.2.3 Condition model (Using Lagrange model)
6.3 Matrix methods in least-squares adjustment
6.4 Adjustment of direct and indirect observations
6.5 Adjustment of survey networks
6.5.1 Level nets
6.5.2 Intersection and resection
6.5.3 Traverse
6.5.4 Trilateration and triangulation
6.5.5 Combined triangulation and trilateration

7 Confidence Region Estimation (8 hours)

7.1 Overview
7.2 Mean squared error and mathematical expectation
7.3 Population parameter estimation
7.3.1 Point estimation of population mean
7.3.2 Interval estimation of population mean
7.3.3 Relative precision estimation
7.3.4 Interval estimation for population variance
7.3.5 Interval estimation for ratio of two population variances

7.4 General comments on confidence interval estimation
7.5 Error ellipse and bivariate normal distribution
7.6 Error ellipses for bivariate parameters
7.6.1 Absolute error ellipses
7.6.2 Relative error ellipses

8 Statistical Testing and Assessment of Results (4 hours)

8.1 Univariate testing
8.2 Multivariate testing

Practical (45 hours)

1. Formulation of mathematical models in geomatics engineering
2. Analysis of univariate, bivariate and multivariate function
3. Computation of correlation and covariance matrix
4. Levelling network adjustment
5. Least square adjustment of intersection and resection
6. Least squares adjustment of a triangulation trilateration
7. Least squares adjustment of a traverse
8. Formulation of error ellipse
9. Univariate and multivariate statistical testing

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1 and 2	6	8
3	3	4
4	8	10
5	4	6
6	12	16
7	8	10
8	4	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Ogundare, J. O. (2018). Understanding Least Squares Estimation and Geomatics Data Analysis. United Kingdom: Wiley.
2. Ghilani, C. D., Wolf, P. R. (2017). Adjustment Computations: Spatial Data Analysis. United Kingdom: Wiley.
3. Anderson, J. M., Mikhail, E. M. (1998). Surveying: Theory and Practice (Latest Edition). Spain: McGraw-Hill Education.
4. Strutz, T. (2016). Data Fitting and Uncertainty: A Practical Introduction to Weighted Least Squares and Beyond. Germany: Vieweg+Teubner Verlag.