NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

METALLURGICAL ENGINEERING PROGRAM

TM301 – GENERAL TOPOGRAPHY

I. GENERAL INFORMATION

CODE	**:**	TM301 General Topography
SEMESTER	**:**	3
CREDITS	**:**	4
HOURS PER WEEK	**:**	6 (Theory – Practice)
PREREQUISITES	**:**	AU521 Descriptive Geometry, MA113 Mathematics I
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

This course deals with subjects such as: Horizontal control using triangulation and trilateration methods. Determination of the relative and total error. Figure compensation methodologies, figure resistance theory, coordinates calculation, off-center station, supplementary horizontal control using direct and inverse intersection (Pothenot problem), volume calculation: methods and considerations, introduction to road theory, applications to mining engineering.

III. COURSE OUTCOMES

At the end of the course, students:

1. Carry out topographical surveys of large and medium expanse controlled with triangulation and apply them to engineering works.
2. Propose several work systems that allow them to represent a stretch of land and take decisions.
3. Students will have the possibility to fit in with criteria and requirements of a certain and specific civil work, so their work meet the needs required.
4. The mastery and practice of this conceptual subject matter will allow students to perform in the technical-professional field of topography, and will also provide students with conceptual basis for their later courses.

IV. LEARNING UNITS

1. CONCEPTS AND PRELIMINARY WORKS / 8 HOURS

Topogrphical triangulation / Planimetric control / Clasification / Common figures / Stages / Work planning / propagation of error / geodesic triangulation / Spherical excess. Terrain reconnaissance / Hub location / Monumentation and hub signaling / Daytime and evening observation / Base measurement / Classification and precisions.

2. ANGULAR MEASUREMENTS / 15 HOURS

Base measurements with steel tape and invar bar / electronic instruments / Base orientation with sight and gyro / GPS. Precision theodolites / Measurement of horizontal angles / for reiteration / Precautions / measurement of vertical angles / trigonometric leveling / Off-center station.

3. ANGULAR MEASUREMENTS II / 12 HOURS

Figure compensation / Method used / Equations of condition. Error theory method / Successive-approximations method / Least squares method. Figure resistance / Side calculation / UTM coordinates calculation / Dimension lines calculation.

4. TACHYMETRY WITH TOTAL STATION AND THEODOLITE / 8 HOURS

Tachymetry / Horizontal and inclined sights / Formulas / Optical and electrical instruments / Total station / Curve diagram tachymeter / Errors and precautions. Elaboration of contour lines / Field and lab research methods / Interpolation / Methods / Verifications / Errors and precautions.

5. SUPPLEMENTARY HORIZONTAL CONTROL / 16 HOURS

Applications for contour lines / Gradient stroke / Construction of sections / Volume calculation / Supplementary horizontal control / Simple intersection / inverse intersection (Pothenot) / Analytical development / Common cases / trilateration with electric instruments. Triangulation application for bridges and tunnels / Triangulation networks for basic and cadastral plans / Supplementary control in photogrammetry. Calculation of areas / Surveying / Planimeter / Coordinates / Decomposition into simple figures / Precisions / calculation of volumes / Topographic laser scanner.

6. USE OF TOPOGRAPHICAL TECHNIQUES / 4 HOURS

Boundary rectification / Gradient line / Circular curves / Bathymetric survey / Budges / test of topographic instruments.

V. LABORATORY AND PRACTICAL EXPERIENCES

Terrain reconnaissance using preliminary works.
Measurement with theodolites.
Equations of condition.
Topographical survey.
Measurement with total station.
Stroke of contour lines.
Triangulation scope and uses.
Calculation of areas.

VI. METHODOLOGY

The course is carried out in theory and practice sessions. In theory sessions, the instructor introduces concepts, theorems and applications. In practice sessions, several problems are solved, and their solutions are analyzed using topographic equipment (topographical level, theodolite, total station, GSP). At the end of the course, students must hand in and expose a paper. In all sessions student's active participation is encouraged.

VII. EVALUATION FORMULA

The average grade PF is calculated as follows:

$$PF = \frac{EP + 2EF + PP}{4} \qquad PP = \frac{PC1 + PC2}{2}$$

EP: Mid-Term Exam EF: Final Exam
PC1, PC2: Quizzes

VIII. BIBLIOGRAPHY

1. **BANNISTER A., RAYMOND S., BAKER R.**
   Modern Techniques in Topography
   Alfa Omega Editions, 2002
2. **DOMINGUEZ GARCIA, Francisco**
   General and Applied Topography
   Dossat Editions, 2005
3. **DAVIS, Raymond**
   Treatise on Topography
   Mc. Graw Hill Editorial, 2005

IX. COURSE CONTRIBUTIONS TO STUDENT OUTCOMES ATTAINMENT

Course contributions to Student Outcomes are shown in the following table:

Level 1: Know
Level 2: Comprehend, calculate
Level 3: Model, apply, solve
Level 4: Apply at advanced level, design. Achievement of Student Outcome

Outcome	Contribution
1. Engineering Design Design and integrate metallurgical systems and components satisfying requirements and needs as well as given technical, economic, social and legal constraints and limitations.	2
2. Problem solving Identify, formulate and solve engineering problems properly using the methods, techniques and tools of metallurgical engineering.	2
3. Sciences Application Apply the knowledge and skills of mathematics, sciences and engineering to solve metallurgical engineering problems.	2
4. Experimentation and Testing Conceive and conduct experiments and tests, analyze data and interpret results.	2
5. Modern Engineering Practice Use and apply techniques, methods and tools of modern engineering necessary for the practice of metallurgical engineering.	2
6. Engineering Impact Understand the impact of metallurgical engineering solutions on people and society in local and global contexts.	2
7. Project Management Determine the budgets, schedules and feasibility of engineering projects, and participate in its management for the attainment of goals.	2
8. Environmental Appraisal Take into account the importance of preserving and improving the environment in the development of their personal and professional activities.	2
9. Lifelong Learning Recognize the need to keep their knowledge and skills up-to-date according to advances of metallurgical engineering and engage in lifelong learning.	2
10. Contemporary Issues Know and analyze relevant contemporary issues in local, national and global contexts.	2
11. Ethics and Professional Responsibility Evaluate their decisions and actions from a moral perspective and assume responsibility for the executed projects.	2
12. Communication Communicate clearly and effectively in oral, written and graphical formats, interacting with different types of audiences.	2
13. Teamworking Appraise the importance of teamworking and participate actively and effectively in multidisciplinary teams.	2