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

GM931 – ANALYSIS OF MINING SYSTEMS

I. GENERAL INFORMATION

CODE	:	GM931 Analysis of Mining Systems
SEMESTER	:	9
CREDITS	:	3
HOURS PER WEEK	:	4 (Theory–Practice)
PREREQUISITES	:	GE701 Mineral Deposits GM824 Minerals and Metals Marketing
CONDITION	:	Compulsory
DEPARTMENT	:	Mining

II. COURSE DESCRIPTION

Analysis, design and programming of a mining system. Statistics applied to quality control. GPSS is used in the mining industry. Development of applications. Development of a transport model in underground mining. The course will be conducted under the face modality with theory, practice and computer lab sessions. In the theory sessions, the instructor introduces the concepts, theorems and applications. In the practical sessions, various problems are solved and their solutions are discussed.

III. COURSE OUTCOMES

1. Organize the tools for the analysis of mining systems.
2. Explain the system of quality control.
3. Understands the simulation of a uniform random variable.
4. Recognizes the full development of a transport system.
5. Analyze the results.

IV. LEARNING UNITS

1. INTRODUCTION / 2 hours

System / models / Model classes.

2. TOOLS FOR THE ANALYSIS OF MINING SYSTEMS / 2 hours

Defining the mining system / Bubble diagram / HIPO diagram (Hierarchy and input / output chart) / Entity relationship diagrams / Flowchart / Programming language code / Computer processing / Pilot test / Analysis of results / Allocation of individual and collective work.

3. QUALITY CONTROL SYSTEM / 4 hours

Introduction / Statistical analysis data / Pareto chart / Cause and effect diagram / Quality control charts / Example: cause and effect model developed for the Caraveli mine.

4. MINING TRANSPORT SYSTEM / 4 hours

GPSS use in the mining industry / Introduction / Simulation of a uniform and non-uniform random variable: Poisson, Erlang and Exponential / Monte Carlo Method / Elements of GPSS: transactions, teams and statistics / GPSS basic instructions to generate transactions / Assignment of uniprocessor equipment / Instructions and queue statistics / Term control process / Basic instructions for multiprocessors / Allocation of multiprocessor computers /

Functions: discrete and continuous / Special variables (Standard Numerical Attributes: SNA) / Parameters / Assignment Instructions / Bifurcations / Conditionals / Conservators of parameter values / Algebraic and logical expressions / Priorities.

5. MINERAL EXTRACTION SYSTEM / 4 hours

Blending problem, theory and examples / Scheduling problems of production, theory and examples.

6. APPLICATIONS DEVELOPED WITH GPS / 4 hours

Shovel-truck system / Systems of maintenance services / Cage system in underground mining / Complete development of a transport system in surface mining / Definition of the problem / Construction of graphic model / Blocks diagram / Language coding of a simulation event to a GPSS event / PC processing / Analysis of results of queues and equipment.

7. DEVELOPMENT OF A TRANSPORT MODEL IN UNDERGROUND MINING / 4 hours

Analysis and design of the operation in short and medium term / Case study of Milpo and Condestable mine developed by the university / Definition of the problem / Bubble diagram / Flowchart / Coding / Processing / Pilot test / Analysis of results.

8. INFORMATION SYSTEM IN MINING / 4 hours

Information gathering / Information processing / Gathering information / Dissemination of information.

9. DESIGN SYSTEMS OF OPENCAST MINES / 4 hours

Korovov algorithm for pit design. Analysis and examples / Lerch and Grossman algorithm for pit design. Analysis and examples / Matheron algorithm for pit design. Analysis and examples / Jeff Whitle algorithm for pit design. Analysis and examples.

V. METHODOLOGY

The course will be conducted under the face modality with theory, practice and computer lab sessions. In the theory sessions, the instructor presents the concepts, theorems and applications. In the practical sessions, various problems are solved and their solutions are analyzed. In the laboratory sessions, specialized simulation software is used to solve problems and their solutions are discussed.

VI. EVALUATION FORMULA

The Average Grade PF is calculated as follow: ***PF* = (*EP* + *EF* + *PP*) / 3**

PP = (three best of (PC1, PC2, PC3, PC4) + M1 + M2) / 5

EP: Mid-Term Exam
EF: Final Exam
PP: Average of practices and monographs
M: Monographs

VII. BIBLIOGRAPHY

1. **COSS BU, RAUL**
   Simulation of Mining Systems. A Practical Approach.
   Limusa Editorial, Mexico, 2004
   .
2. **CHISMAN, JAMES A.**
   Introduction to Simulation Modeling Using GPSS/PC (Minuteman Software)
   Prentice Hall International INC. New Jersey, 2002.

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