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

MA443 – MATHEMATICS IV

I. GENERAL INFORMATION

CODE	**:**	MA443 Mathematics IV
SEMESTER	**:**	4
CREDITS	**:**	5
HOURS PER WEEK	**:**	7 (Theory – Practice)
PREREQUISITES	**:**	MA333 Mathematics III
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

This course is theoretical and practical and provides students with advanced mathematics knowledge and tools to be applied to solve engineering problems. Its main objective is to make students learn to apply all the knowledge acquired in the prerequisite courses to deal with new subjects and, above all, demonstrate the multiple application of mathematics to geological engineering.

III. COURSE OUTCOMES

1. Identify the scientific nature of mathematics and assess the rigor and the objectivity of the discipline contributing to the proper professional training of students.
2. Analyze, interpret, assess and adapt with strategies the fundamental theorems of the course adequately applying them in the solution to specific problems inherent to the career with the necessary thoroughness.
3. Correctly operate with complex numbers, successions, series of powers, ordinary differential equations and creatively find Laplace's transform of real functions.
4. Understand concepts of series of power and apply it to calculate derivatives and integrals and the convergence analysis and assess its importance in engineering problems solving.
5. Define first-order differential equations and classify in separate-homogeneous-exact variables and integrating factor and apply solution methods in every case.
6. Define differential equations with and without damping, and apply it in beams deflection (mathematical models).
7. Define Laplace's transform and inverse Laplace's transform, properties, derivatives and integrals of real functions, real variables with creativity, ability of analysis and constructive vision.

IV. LEARNING UNITS

1. SUCCESSIONS, SERIES AND POWER SERIES / 8 HOURS

Successions of real numbers. Converge criteria and applications. Series of real numbers. Convergence criteria and applications.

2. ORDINARY DIFFERENTIAL EQUATIONS / 8 HOURS

Ordinary differential equations. Order and grade. Differential equations with separable variables. Homogeneous differential equations. Exact differential equations. Some integration factors. Differential, linear and Bernoulli's equations.

3. SECOND-ORDER HOMOGENEOUS AND NON HOMOGENEOUS DIFFERENTIAL EQUATIONS / 12 HOURS

Second-order homogeneous and non-homogeneous differential equations. Solution to non-homogeneous equations. Methods of undetermined coefficients and differential operators. Solution to ordinary differential equations with variable coefficients. Euler's and Legendre's equation.

4. APPLICATION PROBLEMS. BEAMS, DAMPING; LEGENDRE'S, BESSEL'S EQUATIONS; GAMMA AND BETA / 12 HOURS

Application problems: beams and damping. Special functions: Gamma and Beta. Solution to differential equation using power series. Frobenius' theorem. Legendre's equation, Legendre's polynomial.

5. CONTINUOUS FUNTIONS, LAPACE'S TRANSFORM / 16 HOURS

Continuous function in segments and of exponential order. Laplace's transform, properties, theorem, calculation methods and application of Laplace's transform. Inverse Laplace transform, calculation methods. Application of the inverse Laplace's transform. Application of the inverse Laplace's transform to differential equations with constant and variable coefficients, other applications. Systems of 2x2 linear differential equations. Matrix solution for Laplace's transform.

V. 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 types of problems are solved, and their solutions are analyzed. In all sessions student's active participation is encouraged.

VI. EVALUATION FORMULA

The average grade PF is calculated as follows:

PF = (EP + EF + PP) / 3

EP: Mid-Term Exam EF: Final Exam
PP: Average of six quizzes

VII. BIBLIOGRAPHY

1. **DENNIS G. ZILL**
   Differential Equations
   Iberoamerican Editorial, 2009

2. **O. NEIL B.**
   Advanced Mathematics for Engineering
   Continental Editorial, 2009

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