NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF MECHANICAL ENGINEERING
MECHATRONICS ENGINEERING PROGRAM

MB158 – COMPLEX VARIABLE AND FOURIER ANALYSIS

I. GENERAL INFORMATION

CODE	: MB158 Complex Variable and Fourier Analysis
GRADE	: 5
CREDITS	: 3
HOURS PER WEEK	: 4 (Theory – Practice)
PRE-REQUISITES	: MB155 Differential Equations
CONDITION	: Compulsory

II. COURSE SUMMARY

The course is theoretical and practical and has the purpose of providing students of the Faculty of Mechanical Engineering with mathematical concepts to solve engineering problems related to flow lines in a plane, complex potential, heat flow, wave equation, heat equation and Laplace equation.

It includes the study of: Complex functions, Complex functions as mappings, Integration in the complex plane, Complex series, Singularity and the residue theorem, Z-Transform, Fourier series and transform.

III. COMPETENCES

The student:

1. Maps complex functions.
2. Understands and defines an analytical function
3. Constructs analytical functions.
4. Applies the analytical function in problems of stream current lines in a plane.
5. Applies the analytical function in problems of complex potential, heat flow.
6. Applies the Cauchy integral to evaluate complex integrals.
7. Applies the Laurent series and the residue theorem to evaluate complex integrals.
8. Uses the Z-transform in the solution of difference equations.
9. Uses the Fourier series and transform to solve the wave equation, heat and Laplace.

IV. LEARNING UNITS

1. **COMPLEX FUNCTIONS / 14 HOURS**
   Definition of a function in complex variable / Complex functions as mappings / Limit and continuity of a function in complex variable / Derivative of a function in complex variable / Complex derivation formulas / The Cauchy-Riemann equations. Sufficient conditions / Analytical function. Harmonic function / The complex exponential function / The complex logarithm function / Complex trigonometric and hyperbolic functions. Applications.

2. **INTEGRATION IN THE COMPLEX PLANE / 05 HOURS**
   Line Integrals. Definition and properties / The integral of Cauchy-Goursat / Independence of the trajectory / Indefinite integrals: Principle of the independence of the trajectory, integration of analytical functions / Fundamental theorem of function calculus / Cauchy integral theorem / Extension of Cauchy's Integral / Cauchy integral for doubly connected and multiple-connected domains. Applications.

3. **COMPLEX SERIES / 03 HOURS**
   Complex Power Series / Taylor Series / Some Major Maclaurin Series / Laurent Series.

4. **SINGULARITIES AND THE RESIDUE THEOREM / 06 HOURS**
   Classification of singularities / Definition of residue / Calculation of residue / Theorem of residue / The argument principle.

5. **THE Z TRANSFORM / 04 HOURS**
   Definition of the Z-transform / Z-transform of elementary functions / Important properties and theorems of the Z-transform / The inverse Z-transform / Z-transform method for the solution of differential equations.

6. **THE FOURIER SERIES / 10 HOURS**
   Fourier series for a periodic function. Amplitude spectrum / Complex Fourier Series. Amplitude spectrum / Finite Fourier sines transform / Finite Fourier cosines transform / Solution by finite Fourier transform of problems with boundary values: wave, heat and potential equation.

7. **THE FOURIER TRANSFORM / 14 HOURS**
   Definition of the Fourier transform / Fourier transform of special functions / Fourier transform properties / The Fourier transform of a derivative / Differentiation with respect to the frequency variable / Fourier transform of an integral / Definition of convolution / Properties of the Convolution / Dirac Delta Function and Filtering / Solution by Fourier transform of boundary value problems: wave, heat and potential equation.

V. METHODOLOGY

The course is developed in theoretical and practical sessions. In theory sessions, the teacher presents concepts, theorems and applications. In the practical sessions, the directed practice is realized. The students solve diverse problems, they discuss and they consult the professor. In all the sessions the active participation of the student is promoted.

VI. EVALUATION FORMULA

The course will be evaluated according to the 'F' system.
Quizzes Average (P.P.)
Mid-term Exam (E.P.)
Final Exam (E.F.)
Subsanatory Exam (SE), optional.
Number of Quizzes: 04 (four) and the average of the quizzes (P.A.) is the arithmetic average of the 03 highest grades of the quizzes.
The final grade (N.F)

$$\text{N.F.} = \frac{1\text{P.P.} + 1\text{E.P.} + 2\text{E.F.}}{4}$$

VII. BIBLIOGRAPHY

1. **CHURCHILL RUEL V, BROWN JAMES W.** Complex Variable and Applications. Fifth edition. Mc Graw Hill. 1996.
2. **HWEI P. HSU**. Fourier Analysis. First Edition. Addison-Wesley Iberoamericana. 1987.
3. **JAMES GLYN.** Matemáticas Avanzadas para Ingeniería. Second Edition. Prentice Hall. 2002.
4. **KATSUHIKO OGATA**. Discrete-time control systems. Second Edition. Prentice Hall.1996.
5. **KREYSZIG ERWIN**. Matemáticas Avanzadas para Ingeniería-Volumen II. Second Edition. Limusa. 1998.
6. **O'NEIL, PETER**. Matemáticas Avanzadas para Ingeniería. Fifth Edition. Thomson. 2003
7. **SOLIMAN SAMIR Y SRINATH MANDYAM. Señales y Sistemas Continuos y** Discretos. Second Edition. Prentice Hall. 1999.
8. **WEINBERGER HANS**. Ecuaciones Diferenciales en Derivadas Parciales. Reverté S.A. 1996
9. **WUNSCH DAVID**. Variable Compleja con Aplicaciones. Second Edition. Addison-Wesley Iberoamericana. 1997.
10. **ZILL DENNIS, SHANAHAN PATRICK**. Introducción al Análisis complejo con aplicaciones. Second Edition. Cengage Learning. 2009.