



**NATIONAL UNIVERSITY OF ENGINEERING  
COLLEGE OF SCIENCES  
MATHEMATICS PROGRAM**

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**CM424 – INTRODUCTION TO DYNAMIC SYSTEMS**

**I. GENERAL INFORMATION**

<b>CODE</b>	: CM424 Introduction to Dynamic Systems
<b>SEMESTER</b>	: 8
<b>CREDITS</b>	: 4
<b>HOURS PER WEEK</b>	: 6 (Theory – Practice – Seminar)
<b>PREREQUISITES</b>	: CM421 Ordinary Differential Equations I
<b>CONDITION</b>	: Mandatory

**II. COURSE DESCRIPTION**

To study qualitatively, linear dynamic systems in  $\mathbb{R}^2$ ; in particular the linear dynamic systems in the plane ( $\mathbb{R}^2$ ). To use the Phase of a System portrait and observe the qualitative change, when the system depends on some parameter (bifurcations).

**III. LEARNING UNITS**

**1. Linear equations**

Linear systems in the plane, Phase portrait / Linear systems in  $\mathbb{R}^2$ . Topological conjugation / Classification of the singularity of a linear system / Classification of hyperbolic linear systems.

**2. Non-linear equations**

Nonlinear dynamic systems with a hyperbolic linear part / Poincaré transformation. Limit cycles / Equations with periodic coefficients / Poincaré-Bendixon Theorem.

**3. Oscillations in Second Order Equations**

Van Der Pol equation / Liénard equation / Forced oscillations.

**4. General Theory of Oscillations**

Linear systems / Near-linear systems / Non-autonomous Case / Casilinear Systems, Autonomous Case.

**IV. BIBLIOGRAPHY**

- Hartman, Ecuaciones Diferenciales.
- Lefschetz, S., Ecuaciones Diferenciales, Teoría Geométrica.
- Palis, J. de Melo, W., Introducción a los Sistemas Dinámicos.
- Sotomayor, Jorge, Lecciones de Ecuaciones Diferenciales Ordinarias.
- Carlos Imaz Zdenek Vorel., Ecuaciones Diferenciales Ordinarias.