Curriculum for Mathematics M1c - Differential equations (BMETE90MX44)

1. Basic concepts of first-order ordinary differential equations. Initial value problems. Qualitative properties. Existence and uniqueness of the solution.

2. Separable and autonomous differential equations. Application and modeling, physical examples.

3. First order linear differential equations. General solution of nonhomogeneous linear differential equations, variation of the constant method.

4. Models of chemical reactions, examples.

5. Higher order linear differential equations. General solution, basis, particular solution. Linearity principle. Existence and uniqueness theorem for initial value problems. Linear independence of solutions, Wronski determinant.

6. Higher order homogeneous equations with constant coefficients. Characteristic polynomial, characteristic equation (real roots, complex roots, higher multiplicity). General solution of nonhomogeneous linear differential equations. Method of undetermined coefficients. Physical examples.

7. Systems of first order differential equations. Existence and uniqueness theorem. Linear systems. Existence and uniqueness in the linear case, linearity principle. Basis, general solution, Wronskian. Homogeneous systems with constant coefficients. Conversion of an nth order differential equation to a system.

8. The Laplace transform and its applications.

9. Power series method.

10. Phase portraits of planar linear systems, the trace-determinant plane.

11. Qualitative methods for nonlinear systems. Linearization of nonlinear systems.

12. Criteria for stability. Lyapunov's method. First integrals. Lyapunov functions. Applications, the Lotka-Volterra population model. Bendixson's criterion, Bendixson-Dulac theorem.