King Fahd University of Petroleum and Minerals
Department of Mathematics and Statistics

SYLLABUS

Term 121- 2012-2013

Instructor: Prof. Abdelkader Boucherif

Course No.: MATH 465

Title: Ordinary Differential Equations

Textbook: The Qualitative Theory of Ordinary Differential Equations,An Introduction by F. Brauer and J. A. Nohel, *Dover Publications, Inc. NY (1969)*

Reference A First Course in the Qualitative Theory of Differential Equations
By J. Hetao Liu. *Prentice Hall-Pearson Education, Inc. (2003)*

Course Description: Existence, uniqueness and continuation of solutions to initial value problems (scalar, 1st order systems and linear systems). Linear systems: Solution matrix. Fundamental matrix. Variation of constants method. Phase space analysis. Autonomous systems. Definitions of stability. Stability for linear and almost linear systems. Basic concepts of Lyapunov's method for nonlinear systems.

Week	Date	Sec.	Material
1 – 3	Sept. 1- 5 Sept. 8-12 Sept. 15-19	*Chapter 1*	**Systems of Differential Equations** 1.1 A simple mass-spring system 1.2 Coupled mass-spring systems 1.3 Systems of first-order equations 1.4 Vector-matrix notation for systems 1.5 The need for a theory 1.6 Existence, uniqueness and continuity 1.7 The Gronwall Inequality
4 – 7	Sept. 22-29 Sept. 29- Oct.3 Oct. 6-10 Oct. 13-17	*Chapter 2*	**Linear Systems with an Introduction to Phase Space Analysis** 2.1 Introduction 2.2 Existence and uniqueness for linear systems 2.3 Linear homogeneous systems 2.4 Linear non homogeneous systems 2.5 Linear systems with constant coefficients 2.6 Similarity of matrices and the Jordan canonical form 2.7 Asymptotic behavior of solutions of linear systems with constant coefficients 2.8 Autonomous systems – Phase space – Two-dimensional systems 2.9 *Linear systems with periodic coefficients
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8 – 9	Nov. 3-7 Nov. 10-14 Nov. 17-21	*Chapter 3*	**Existence Theory** 3.1 Existence in the scalar case 3.2 Existence theory for systems of first-order equations 3.3 Uniqueness of solutions 3.4 Continuation of solutions 3.5 Dependence on initial conditions and parameters
10 – 12	Nov. 24-28 Dec. 1-5 Dec. 8-12	*Chapter 4*	**Stability of Linear and Almost Linear Systems** 4.1 Introduction 4.2 Definitions of stability 4.3 Linear systems 4.4 Almost linear systems 4.5 Conditional stability 4.6 Asymptotic equivalence 4.7 Stability of periodic solutions
13 – 15	Dec. 15-19 Dec. 22-26 Dec. 29	*Chapter 5*	**Lyapunov's Second Method** 5.1 Introductory remarks 5.2 Lyapunov's theorems 5.3 Proof of Lyapunov's theorems (optional) 5.4 Invariant sets and stability 5.5 The extent of asymptotic stability – Global asymptotic stability 5.6 Non autonomous systems