Department of Mathematics

College of Science

University of Salahaddin

Subject: Dynamical systems II

Course Book: Third Year Mathematics

Lecturer's name: Chiman M. Qadir

Academic Year: 2022/2023 Second session

Course Book

1. Course name	**Dynamical systems II**
2. Lecturer in charge	Chiman M. Qadir
3. Department/ College	**College of Science- Department of Mathematics**
4. Contact	**e-mail: chiman.qadir@su.edu.krd** **Tel: (optional)**
5. Time (in hours) per week	**Theory: 2 discussion: 0** **Practical: 0**
6. Office hours	**Thirsday (11:00-1:00)**
7. Course code	
8. Teacher's academic profile	**Name:Chiman M.qadir** Work Address: Mathematics Department, College of Science, Salahaddin University-Erbil. **Employment** October 2010– up to now: Mathematics Department, College of Science, Salahaddin University-Erbil **Qualifications & background** B. Sc., Salahaddin University-Erbil, College of Science, Mathematics Department, Iraq. M. Sc., Salahaddin University -Erbil, College of Science, Mathematics Department, Iraq. **General specialization:** Mathematics. **Specific specialization:** Differential Equations. **Assignments** 2010-2022: Assistant Lecturer, Department of Mathematics, Salahaddin University -Erbil, Iraq.
9. Keywords	Dynamical Systems of Differential equations system, periodic solution ,limit cycle, liapanov function bifurication and Discrete dynamical systems

10. Course overview: A limit cycle in a two-dimensional system is a closed trajectory that a system follows over time, returning to its initial state after a certain period. Limit cycles are important in dynamical systems because they describe the long-term behavior of the system, which can be useful for understanding and predicting the behavior of the system. In particular, limit cycles can be used to describe the behavior of systems that exhibit periodic or oscillatory behavior, such as the motion of a pendulum or the behavior of a population in an ecosystem.

A Lyapunov function can be used to prove the stability of an equilibrium point of a two-dimensional system. If a Lyapunov function can be found for a given system, it can be used to prove that the equilibrium point is stable, meaning that the system will tend to the equilibrium point as time goes on. Bifurcation is the phenomenon where a small change in a system's parameters leads to a qualitative change in its behavior. In one and two dimensional systems, bifurcations can be used to study the stability of fixed points and the emergence of periodic or chaotic behavior. This can be useful in a variety of fields, including physics, engineering, and biology, as it can help to understand how small changes in a system can lead to large changes in its behavior. Discrete dynamical systems are systems that change over time in discrete steps, rather than continuously.

12. Student's obligation

Class attendance is mandatory. Although I do not have a rigid policy, anyone who has missed lots of class and is doing poorly in the course should not expect much sympathy from me. If you do miss a class, it is your responsibility to make up the material and make sure your homework is turned in on time

13. Forms of teaching

Many tools will use during the lecture.

14. Assessment scheme

The academic year contain two obligatory exams with average 30% degree and 10% Quizzes. The other will be reserved for final exam.

15. Student learning outcome:

1) studying limit cycles can be useful for students because it helps them to understand the behavior of a wide range of systems, develops analytical skills and provides insight into the stability and chaos of the system.

2) Lyapunov theory is a mathematical framework for analyzing the stability of dynamical systems. It is used to determine whether a system is stable, asymptotically stable, or unstable, based on the behavior of certain Lyapunov functions. This theory can be applied to a wide range of fields including physics and engineering

3) Bifurcation theory is a branch of mathematics that deals with the qualitative changes in the behavior of dynamic systems as a system parameter is varied. It is used to study how the solutions of a system change as a parameter is varied and how different types of behavior can arise from small changes in the parameter.

4) The main advantage of discrete-time systems is that they are easy to analyze mathematically, and they can be simulated on computers. This allows for the prediction of the future behavior of the system based on its past behavior and initial conditions

16. Course Reading List and References:

- Gerald Teschl. *Ordinary Differential Equations and Dynamical Systems*
- David G. Schaeffer and John W. Cain. *Ordinary Differential Equations: Basics and Beyond*
- D.K. Arrowsmith. *Ordinary differential equations*.
- Steven H. Strogatz. *Nonlinear dynamics and Chaos*
- Richard A. Holmgren. *A First Course in Discrete Dynamical Systems*

17. The Topics:	Lecturer's name	NO. HOUER
1 limit cycles 1. Periodic orbits 2. limit cycles, type of limit cycles 3. testing for limit cycles 4. Poincare-Bendixon theorem 5. stability of periodic orbits 6. Index method 2 Method for determine the stability of the fixed points 1. Introduction of Lyapunov functions 2. Lyapunov stability theorem 3.Bifurcation 1. One dimensional flows Geometric representation 2. Fixed points. 3. Stability analysis. Saddle node bifurcation. 4. Transcritical bifurcation. 5. Pitchfork bifurcation. 6. Bifurcation diagrams. 7. Hopf –bifurcation in two dimensional systems 4)Discrete dynamical systems One-dimensional Maps 1). Fixed points 2). Periodic points 3) stability(Sinks, sources and saddles) 4) bifurcation and their types		