# ÇANKAYA UNIVERSITY
# Faculty of Arts and Sciences
## Course Definition Form

### Part I. Basic Course Information

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Department Name** | MATHEMATICS | | | | | **Dept. Numeric Code** | 27 |
| **Course Code** | MATH483 | **Number of Weekly Lecture Hours** | 3 | **Number of Weekly Lab/Tutorial Hours** | 0 | **Number of Credit Hours** | 3 |
| **Course Web Site** | http:// math483.cankaya.edu.tr | | | | | **ECTS Credit** | 05 |

| **Course Name** *This information will appear in the printed catalogs and on the web online catalog.* | |
|---|---|
| English Name | An Introduction to Continuous Dynamical Systems |
| Turkish Name | Sürekli Dinamik Sistemlere Giriş |

**Course Description**
*Provide a brief overview of what is covered during the semester. This information will appear in the printed catalogs and on the web online catalog. Maximum 60 words.*

Lyapunov Functions. Poincare maps. Center manifolds and normal forms. Periodic Solutions. Equilibrium Solutions. Local bifurcations. Global bifurcations and chaos.

| | | | | |
|---|---|---|---|---|
| **Prerequisites** (if any) *Give course codes and check all that are applicable.* | 1st | 2nd | 3rd | 4th |
| | ☐ Consent of the Instructor | ☐ Senior Standing | ☐ Give others, if any. | |
| **Co-requisites** (if any) | 1st | 2nd | 3rd | 4th |
| **Course Type** *Check all that are applicable* | ☐ Must course for dept. | ☐ Must course for other dept.(s) | ☒ Elective course for dept. | ☒ Elective course for other dept.(s) |

**Course Classification**
*Give the appropriate percentage for each category.*

| Category | Mathematics & Natural Sciences | Engineering & Architectural Sciences | | | |
|---|---|---|---|---|---|
| Percentage | 80 | 20 | | | |

## Part II. Detailed Course Information

**Course Objectives**
*Maximum 100 words.*

To learn how to analyze mathematical models of real world problems using modern methods of nonlinear dynamics.

**Learning Outcomes**
*Explain the learning outcomes of the course. Maximum 10 items.*

The students will learn basic concepts about equilibrium solutions, periodic solutions, local and global bifurcation, chaos theory, normal forms, center manifold and they will learn how to apply these theoretical results to real world problems in science, engineering, biology, etc.

**Textbook**(s)
*List the textbook(s), if any, and other related main course material.*

| Author(s) | Title | Publisher | Publication Year | ISBN |
|---|---|---|---|---|
| S. H. Strogatz | Nonlinear Dynamics and Chaos : With Applications to Physics, Biology, Chemistry, and Engineering | Westview | 2015 | 978-0813349107 |
| | | | | |

**Reference Book**s
*List, if any, other reference books to be used as supplementary material.*

| Author(s) | Title | Publisher | Publication Year | ISBN |
|---|---|---|---|---|
| K.T. Alligood, T.D. Sauer, J.A. Yorke | Chaos -An Introduction to Dynamical Systems | Springer Verlag | 1996 | 978-0387946771 |
| P. Lawrence | Differential equations and dynamical systems | Springer | 2001 | 0387951164 |
| S. Wiggins. | Introduction to Applied Nonlinear Dynamic Systems and Chaos. | Springer Verlag, New York | 2003 | 978-0-387-00177-7 |
| J. Guckenheimer, P. Holmes | Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields, | Springer Verlag, | 2002 | 978-0-387-90819-9 |

**Teaching Policy**
*Explain how you will organize the course (lectures, laboratories, tutorials, studio work, seminars, etc.)*

3 hours of lecturing per week. Attendance is compulsory.

**Laboratory/Studio Work**
*Give the number of laboratory/studio hours required per week, if any, to do supervised laboratory/studio work and list the names of the laboratories/studios in which these sessions will be conducted.*

**Computer Usage**
*Briefly describe the computer usage and the hardware/software requirements for the course.*

**Course Outline**
*List the weekly topics to be covered.*

| Week | Topic(s) |
|---|---|
| 1 | Linear Systems, Diagonalization, Complex eigenvalues, Multiple eigenvalues |
| 2 | Linear Systems (Continued), Jordan Forms, Phase Plane, Stability theory, nonhomogenous systems |
| 3 | Nonlinear Systems, Exixtence-Uniqueness Theorem, Maximal interval of existence |
| 4 | Linearization, The stable manifold theorem, invariant manifolds, stable, unstable and center manifolds, |
| 5 | Lyapunov Functions, stability and instability theorems, |
| 6 | Lyapunov Stability Theory (continued), examples from real world applications. |
| 7 | Center Manifold theory, Normal Form Theory |
| 8 | Gradient and Hamiltonian systems |
| 9 | Global existence Theorems, Limit sets, attractors, periodic orbits |
| 10 | The Poincare map, The stable manifold theorem for periodic orbits |
| 11 | The Poincare-Bendixson Theory |
| 12 | Index theory. Bifurcation theory. Basic concepts. |
| 13 | Saddle-node, transcritical, pitchfork and Hopf Bifurcations. Oscillating chemical reactions. |
| 14 | Chaos Theory. Lorenz Equations. A chaotic waterwheel. |

**Grading Policy**
*List the assessment tools and their percentages that may give an idea about their relative importance to the end-of-semester grade.*

| Assessment Tool | Quantity | Percentage | Assessment Tool | Quantity | Percentage | Assessment Tool | Quantity | Percentage |
|---|---|---|---|---|---|---|---|---|
| Homework | | | Case Study | | | Attendance | | |
| Quiz(es) | | | Lab Work | | | Field Study | | |
| Midterm Exam | 2 | 50 | Classroom Participation | | | Project | | |
| Term Paper | | | Oral Presentation | | | Final Exam | 1 | 50 |

**ECTS Workload**
*List all the activities considered under the ECTS.*

| Activity | Quantity | Duration (hours) | Total Workload (hours) |
|---|---|---|---|
| Attending Lectures (*weekly basis*) | 14 | 3 | 42 |
| Attending Labs/Recitations (*weekly basis*) | | | |
| Compilation and finalization of course/lecture notes (*weekly basis*) | 14 | 1 | 14 |
| Collection and selection of relevant material (*once*) | 1 | 5 | 5 |
| Self study of relevant material (*weekly basis*) | 14 | 1 | 14 |
| Take-home assignments | | | |
| Preparation for quizzes | | | |
| Preparation for mid-term exams (*including the duration of the exams*) | 2 | 15 | 30 |
| Preparation of term paper/case-study report (*including oral presentation*) | | | |
| Preparation of term project/field study report (*including oral presentation*) | | | |
| Preparation for final exam (*including the duration of the exam*) | 1 | 20 | 20 |
| | | TOTAL WORKLOAD / 25 | 125/25 |
| | | **ECTS Credit** | **5** |

*Total Workloads are calculated automatically by formulas. To update all the formulas in the document first press CTRL+A and then press F9.*

**Program Qualifications vs. Learning Outcomes** *Consider the program qualifications given below as determined in terms of learning outcomes and acquisition of capabilities for all the courses in the curriculum. Look at the learning outcomes of this course given above. Relate these two using the Likert Scale by marking with X in one of the five choices at the right.*

| No | Program Qualifications | Contribution | | | | |
|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 |
| 1 | Adequate knowledge in mathematics; ability to use applied and theoretical information in these areas to solve pure and applied mathematical problems. | | | | X | |
| 2 | Ability to use modern computational tools to analyze an abstract or real life problem | | | | X | |
| 3 | Adequate knowledge in theoretical and historical background in mathematics | | | | X | |
| 4 | Ability to work individually and in teams efficiently, ability to collaborate effectively in teams to analyze complex systems from intra-disciplinary and multi-disciplinary areas | | | | X | |
| 5 | Ability to communicate effectively in English about technical subjects, both orally and in writing | | | | X | |
| 6 | Ability to use, develop and implement new experiments and algorithms to solve scientific, engineering and financial problems | | | | X | |
| 7 | Ability to analyze a mathematical problem using both analytical and numerical methods; use and compare theoretical and simulational methods to gain deeper insight | | | | X | |
| 8 | Ability to report the findings, conclusions and interpretations related to a project in the area of pure and applied mathematics, ability to write technical reports, to prepare and conduct effective presentations | | | | X | |
| 9 | Recognition of the need for lifelong learning; ability to access information, to follow developments in science and technology, and to keep continuous self improvement | | | | X | |
| 10 | Awareness of professional and ethical responsibility issues and their legal consequences | | | | | X |

Scale for contribution to a qualification: **0**-none, **1**-little, **2**-moderate, **3**-considerable, **4**-highest