مركز الاعتماد وضمان الجودة
ACCREDITATION & QUALITY ASSURANCE CENTER

**The University of Jordan Accreditation & Quality Assurance Center**

# Course Syllabus

# Course Name: Dynamical Systems

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|---|---|---|
| 1 | **Course title** | Dynamical Systems |
| 2 | **Course number** | 0301905 |
| 3 | **Credit hours (theory, practical)** | 3 |
| | **Contact hours (theory, practical)** | 3 |
| 4 | **Prerequisites/requisites** | none |
| 5 | **Program title** | Ph.D. in Mathematics |
| 6 | **Program code** | |
| 7 | **Awarding institution** | The University of Jordan |
| 8 | **Faculty** | Science |
| 9 | **Department** | Mathematics |
| 10 | **Level of course** | Elective specialization requirement |
| 11 | **Year of study and semester (s)** | 2nd year |
| 12 | **Final Qualification** | Ph.D. in Mathematics |
| 13 | **Other department (s) involved in teaching the course** | None |
| 14 | **Language of Instruction** | English |
| 15 | **Date of production/revision** | 13/10/2020 |

**16. Course Coordinator:**

Name: Dr. Ahmed Y. Abdallah Office number:22109
Phone number: 0797911509 Email:
farah@ju.edu.jo

**17. Other instructors**:

None

**18. Course Description:**

Fundamental concepts, extensive survey of examples, equivalence and classification of dynamical systems, principal classes of asymptotic invariants, circle maps, chaos

**19. Course aims and outcomes:**

**A- Aims:**

1- To Discuss several elementary fundamental examples which are related to dynamical systems.
2- To encounter a number of useful concepts related to the asymptotic behavior of dynamical systems.
3- To introduce natural equivalence relations between dynamical systems associated with various classes of coordinate changes.
4- To interpret the problem of description of the orbit structure as the classification of dynamical systems with respect to equivalence relations.
5- To study principal classes of asymptotic topological invariants.
6- To investigate the asymptotic distribution and statistical behavior of orbits.

**B- Intended Learning Outcomes (ILOs): Upon successful completion of this course students will be able**

**A. Knowledge and Understanding Skills:** Student is expected to

A1) Understand the given fundemental examples.

A2) know the basic concepts related to the asymptotic behavior of dynamical systems.

**B. Intellectual Analytical and Cognitive Skills:** Student is expected to

B1) Analyze the asymptotic behavior for some dynamical systems.

B2) Descripe the orbit structure as the classification of dynamical system with repect to equivalence relations.

**C. Subject- Specific Skills:** Student is expected to

C1) Solve some problems related to the given examples.

C2) Discuss the principal classes of asymptotic topological invariants C3)

Interpret the asymptotic distribution and statistical behavior of orbits.

**D. Creativity /Transferable Key Skills/Evaluation:** Student is expected to

D1) Be involved in the process of illustrating concepts, building models and exploring facts. D2)

Make critical comments on obtained results.

D3) Write reports, to be involved in general discussions with his class mates, and to do independent work.

**20. Topic Outline and Schedule:**

| Topic | Week | Instructor | Achieved ILOs | Evaluation Methods | Reference |
|---|---|---|---|---|---|
| Introduction:<br>1. Principal branches of dynamics.<br>2. Flows, vector fields, differential equations.<br>3. Time-one map, section, suspension.<br>4. Linearization and localization | 1 | | 1 | | 1 |
| First Examples:<br>1. Maps with stable asymptotic behavior.<br>2. Linear maps.<br>3. Rotations of circles.<br>4. Translations on the torus.<br>5. Linear flow on the torus and completely integrable systems.<br>6. Gradient flows.<br>7. Expanding maps.<br>8. Hyperbolic toral automorphisms.<br>9. Symbolic dynamical systems. | 2-4 | | 2 | Homework1 | 1 |
| Equivalence, Classification, and Invariants:<br>1. Smooth conjugacy and moduli of maps<br>2. Smooth conjugacy and time change for flows.<br>3. Topological conjugacy, factors, and structural stability.<br>4. Topological classification of expanding maps on a circle.<br>5. Coding, horseshoes, and Markov partitions.<br>6. Stability of hyperbolic toral automorphisms.<br>7. The fast-converging iteration method for the conjugacy problem.<br>8. The Poincare-Siegel Theorem.<br>9. Cocycles and cohomological equations. | 5-8 | | 3 | Mid Exam | 1 |
| Principal Classes of Asymptotic Topological Invariants:<br>1. Growth of orbits.<br>2. Examples of calculation of topological entropy.<br>3. Recurrence properties. | 9-11 | | 3 | HomeWork 2 | 1 |

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|---|---|---|---|---|---|
| Statistical Behavior of Orbits and Inroduction to Ergodic Theory:<br>1. Aysmptotic distribution and statistical behavior of orbits.<br>2. Examples of ergodicity.<br>3. Measure-theoretic entropy.<br>4. Examples of calculation of measure-theoretic entropy.<br>5. The variational principle. | 12-15 | | 4 | Final Exam | 1 |

**21. Teaching Methods and Assignments:**

**Development of ILOs is promoted through the following teaching and learning methods:**
**In order to succeed in this course, each student each student need to be an active participant in learning- both in class and out of class.**

- Class time will be spent on lecture as well as discussion of homework problems and some groupwork
- To actively participate in class, you need to prepare by reading the textbook and doing all assigned homework before class.
- You should be prepared to discuss your homework.
- You are encouraged to work together with other students and to ask questions and seek help from the professor, both in and out of class

**22. Evaluation Methods and Course Requirements:**

**Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:**

| ILO/s | Learning Methods | Evolution Methods | Related ILO/s to the program |
|---|---|---|---|
| | **Lectures** | **Exam** | |
| | **Published Papers** | **Presentation** | |
| | | **Home work** | |

**23. Course Policies:**

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| Class attendance of students at the beginning of the lecture is recoded. |
| Assignment is given to the students at regular intervals for them to solve and submit. Late or no submission of assignments carries penalties or loss of grade points. |
| Absences recorded in each lecture with making excuses, if any. |

**24. Required equipment:**

**25. References:**

A- Required book (s), assigned reading and audio-visuals:

1. Introduction to the Modern Theory of Dynamical Systems, A. Katok & B. Hasselblatt.

B- Recommended books, materials, and media:

1. Differential Equations, Dynamical systems, and an Introduction to Chaos, M. W. Hirsch, S. Smale, and R. L. Devaney.
2. Chaos: An Introduction to Dynamical Systems, K. T. Alligood, T. D. Sauer, and J. A. Yorke.

**26. Additional information:**

Name of Course Coordinator : Dr. Ahmed Y. Abdallah Signature : ---------- Date : ----------

Head of curriculum committee/Department : ---------- Signature : ----------

Head of Department : Dr . Morad Ahmad Signature : ----------

Head of curriculum committee/Faculty : ---------- Signature : ----------

Dean : Prof. Mahmoud AlJaghoub Signature : ----------

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Assistant Dean for Quality Assurance
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