Advanced Theory of Complex System Engineering

2 units (selection)

Tetsushi Ueta · Professor / Applied Information Media Engineering, Information Science and Intelligent Systems, Systems Innovation Engineering

Target⟩ comprehension and application of complex systems by using engineering methodlogies

Outline⟩ Complex systems are defined as compound dynamical systems whose behavior and features cannot be predicted because of their nonlinearities and connecting conditions. This emergence of behavior is not possible for a single dynamcal system, therefore, connection, coupling, compounding are keywords of this theory. Emergence of rhythm in biological systems, self organization, chaotic properties in high degrees of freedom, learning and associative memory are example features of complex systems. In this lecture, based on physical systems which are ubiquitously found and treated by system engineering subjects, we study analytical methods to understand these phenomena, bifurcation theory of nonlinear and linear systems, applied extraction methods of valuable information from observed data, system design methods of compound dynamical systems.

Style⟩ Lecture

Keyword⟩ ***complex systems, bifurcation, chaos, nonlinear phenomena***

Fundamental Lecture⟩ "**Differential Equations (II)**"(1.0), "**Transient Analysis**" (1.0), "**Industrial Basic Physics**"(1.0)

Relational Lecture⟩ "**Advanced Electrical Control System**"(0.5), "**Advanced Theory of Electronic Circuits**"(0.5)

Requirement⟩ none

Goal⟩

1. understanding of the definition and target area of complex systems
2. understanding of qualitative approach for given dynamical system
3. understanding and application of bifurcation theory

Schedule⟩

1. examples of complex systems
2. relationship between bifurcation problems and complex systems
3. comptation of bifurcation parameter values
4. chaos and bifurcation phenomenon
5. chaotic itinerary
6. emergence mechanism of spatio temporal chaos and its clustering
7. phase transition and synchronization
8. spatio temporal intermittency and emergence of patterns
9. chaos neural network
10. neuronal circuits as complex systems
11. bifurcations in emergence systems
12. analysis of social systems
13. survey on complex systems
14. exercise 1
15. exercise 2
16. questions and answers

Evaluation Criteria⟩ The total grade is evaluated by homework reports (70 %) and attendance of the class. (30 %)

Textbook⟩ specified every class.

Reference⟩ Chaotic Scenario of Complex Systems, Asakura-Shoten, 1996 (in Japanese)

Contents⟩ http://cms.db.tokushima-u.ac.jp/cgi-bin/toURL?EID=216858

Student⟩ Able to be taken by only specified class(es)

Contact⟩

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(Office Hour: Wednesday, afternoon)

Note⟩

◇ For comprehension of the lecture contents, a 2-hour preparation study and a 2-hour review are required.
◇ All items in the lecture plan are evaluated by reports.