Hans Liljenström/SLU

Exam in
Systems Analysis for Sustainable Development, TN0268
Wednesday 15 February 2012, 9-12

Mark on every sheet: Code and problem number.

Aid: Pens/pencils and paper.

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Mark clearly one option, unless otherwise stated. Each question can give 2 or 4 points, as indicated, amounting to a max of 40 points, of which half is sufficient for passing.

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1. System theory (2p)

In the taxonomy of sciences and systems (one of the figures in the course literature and in lecture notes), system theory is divided into "hard" and "soft" system theory. Which two of the following sciences are considered to deal with "soft" systems:

a) Chemistry
b) Economics
c) Biology
d) Sociology
e) Zoology

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2. Energy flow in nature (2p)

In Nature, ecological efficiency is general considered to be around 10% in the transfer from one trophic level to another. If the energy stored in green plants is 1000 kJ, how much of this energy can we make use of by eating meat (e.g. from cows that eat plants)?

a) 1 kJ
b) 10 kJ
c) 20 kJ
d) 100 kJ
e) 200 kJ

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3. Emergent properties (2p)

Which of the following statements fits best for *emergent* properties?

a) Hierarchical structures that are interlinked with the environment
b) New qualities that may arise above a certain threshold of complexity
c) Certain system qualities that are indeterministic but predictable
d) Properties that can be understood fully from knowledge of the parts
e) Self-organised stochastic features of complex systems

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4. Occam's razor (2p)

Which of the following does best describe "Occam's razor":

a) A method to reduce the errors in a model
b) A coordinate system for space-time relation
c) A rule suggesting the environment to be as clean as possible
d) A rule that suggests a model to be as simple as possible
e) A natural law of simplicity

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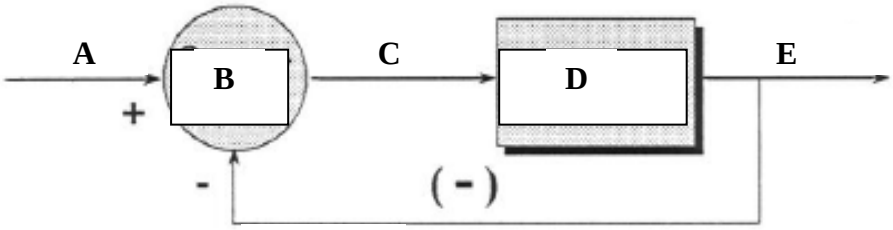
5. Control (2p)

A negative feedback mechanism enables control by comparing the "real value" to the "goal" for natural, technical, as well as for social systems. In the figure below, where should the word "real value" be put?

a) At A
b) At B
c) At C
d) At D
e) At E



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6. Control (2p)

In the figure above, where should the word "comparator" be put?

a) At A
b) At B
c) At C
d) At D
e) At E

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7. Negative feedback (2 p)

If you have a system with a negative feedback loop, *reducing* this feedback effect will generally

a) increase the input signal
b) increase the output signal
c) reduce the output signal
d) reduce the input signal
e) none of the above

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8. Optimisation (2p)

What is meant by optimisation?

a) To determine where a function is increasing
b) To find out where a system is stable and unstable
c) To find the extremum of a function under given conditions
d) To find out how sensitive a system is to disturbances
e) To determine if a function is continuous in the entire interval

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9. Socio-ecological system property (2 p)

The capacity of a socio-ecological system both to withstand perturbations from e.g. climate or economic shocks and to rebuild and renew itself afterwards, is best termed**:**

a) Stability
b) Self-organisation
c) Resilience
d) Vulnerability
e) Sensitivity

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10. Planetary boundaries (2p)

Which two of the following planetary boundaries, as discussed in Rockström et al (2009) have already exceeded the "safe boundary":

a) Chemical pollution
b) Stratospheric ozone depletion
c) Biodiversity loss
d) Ocean acidification
e) Nitrogen cycle

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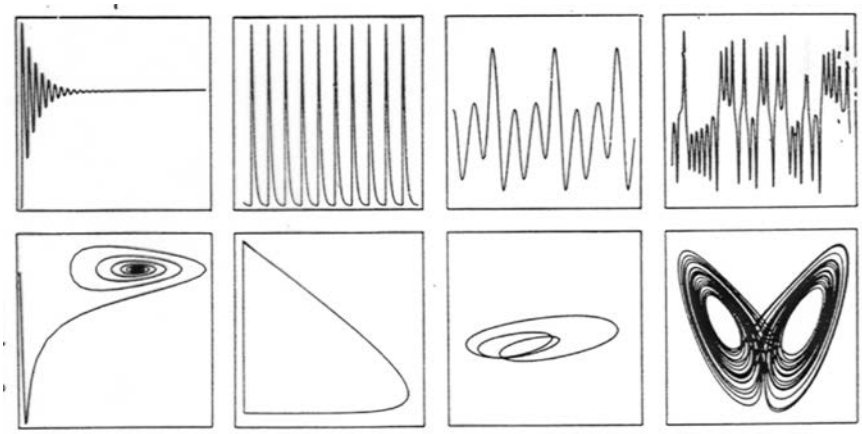
11. <u>Non-linear dynamics (4p)</u>

Describe the figure below and what the different graphs imply. Which types of dynamics are shown? What are the x- and y-axes, respectively in the different cases?



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12. <u>Stochastic and deterministic models (4p)</u>

Explain what is meant by deterministic and stochastic processes, and what is the major difference between them. What distinguishes chaos from noise? When is it reasonable to introduce randomness (stochasticity) in the model, and what problems may arise from this?

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13. <u>Sensitivity analysis (4p)</u>

What is sensitivity analysis and why and when should it be used? Describe the different steps in a sensitivity analysis!

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14. <u>Micro – meso – macro (4p)</u>

What is meant by *micro- meso- and macro scales*? How can you deal with different scales in systems analysis? Give an example, related to sustainable development, where different scales can be modelled. How can different scales be linked? You may base your answers and discussion on the handout chapters of the book, "*Micro-Meso-Macro: Addressing Complex Systems Couplings*" (eds. Liljenström & Svedin, 2005).

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15. <u>Planetary Boundaries (4p)</u>

Identifying and quantifying planetary boundaries that must not be transgressed could help prevent human activities from causing unacceptable environmental change, argue Rockström and colleagues in *Nature*, 24 Sep 2009. Nine different planetary boundaries are suggested in the article. Discuss some (at least three) of these boundaries and which assumptions and calculations that have been made. What role do non-linearities and threshold play? Describe what could happen if any of the boundaries is crossed? What are the strengths and weaknesses of this kind of studies?

Good luck!
Hans