Examples of theoretical questions for the CMBS exam

Remark. This document contains a list of question whose answers cover all the theoretical arguments of the course but recall that these are just examples of possible theoretical questions.

Dynamical system questions

1. Explain the concept of dynamic system, state variable and how to classify them.
2. Explain the concept of movement for a discrete dynamical system, how to compute them for a generic dynamical system and for an LTI system.
3. Explain the concept of equilibrium for a discrete dynamical system, how to find them for a generic dynamical system and for an LTI system.
4. Explain the concept of stability of a movement and for LTI systems, how to assess the stability of an LTI system.
5. Explain the concept of equilibrium for a continuous-time dynamical system, how to find them for a generic dynamical system and for an LTI system.
6. Explain the concept of stability of a movement and for continuous-time LTI systems, how to assess the stability of a continuous-time LTI system.
7. Discuss the various ways to represent a discrete-time dynamical system: state-space, transfer function, recursive form.
8. Explain the properties of a FIR system.
9. State the frequency response theorem and explain the concept of frequency response function.

Fourier analysis questions

1. Explain the Fourier series and transform.
2. Explain the concept of sampling of a signal and the Shannon-Nyquist theorem.
3. Explain the Discrete Fourier Transform.

Nonnegative and compartmental systems

1. Explain what a nonnegative system is and discuss the concept of semistability.
2. Explain what a compartmental model represents and discuss the properties of a compartmental matrix.
3. Discuss a possible way to assess the stability of a linear compartmental system.

Epidemiological models

1. Explain the concept and the properties of a SIR model.
2. Analyze the stability conditions of an SIR model.
3. Discuss the differences between SIR, SIS, SEIR, SIRV models.
4. Discuss the concept of Basic Reproduction Number.

Pharmacokinetics models

1. What is a pharmacokinetic model? Which are its main parameters?
2. Explain the concept of half-life of a drug.
3. Explain the concept of bioavailability.
4. Discuss the properties of a pharmacokinetic model with absorption compartment.
5. In the definition of a multidose posology protocol, which factors should be taken into account?

Identification questions

1. Discuss the difference between white, black and grey box modeling.
2. Explain the concept behind the output prediction error method for system identification.
3. Discuss the implication on the identification of the various form (quadratic, convex and non-convex) that the cost function can have.
4. Explain the problem of overfitting and underfitting and show a possible way to resolve this problem.
5. Explain the concept of validation.
6. Explain the concept of a priori identifiability.
7. Discuss the steps of the identification process.