

Life Data Epidemiology
2022-2023, Master in Physics of Data, Prof. C Poletto
List of questions for the written test

The written test will include 6 questions among the ones listed below. Students will have to choose 4 among the 6. Only 4 answers will be considered and evaluated – the 4 ones returned by the student. The other two will be ignored.

Each answer must stay within an A4 paper (front and back). Only one paper for each answer can be returned.

- 1) Compartmental models: introduce the general concept and the simplifying assumptions, provide some examples of compartmental models (no need to discuss them in detail)
- 2) Present in detail the mathematical formulation of the SIR compartmental model
- 3) Present in detail the mathematical formulation of the SIS compartmental model
- 4) Epidemic threshold and basic reproductive ratio: introduce the two concepts, highlight the relationship between them, discuss the two concepts in relation with the herd immunity threshold and vaccination
- 5) Gamma-trick to describe the non-Markovian infection dynamics
- 6) Relationship between R_0 and the exponential growth of an epidemic: renewal equation to properly account for the generation time distribution, basic mathematical concept and implications.
- 7) The R_t -index: concept, different mathematical definitions and calculation approaches
- 8) Generation time and serial Interval: definitions, relationship between generation time and serial interval
- 9) Incidence: definition of incidence (i.e. define the numerator and the denominator), sensitivity and specificity of a case definition, example of typical problems and biases that may affect the incidence estimation.
- 10) Network models: present one at your choice between the Erdős–Rényi and the Barabási–Albert models
- 11) Epidemic threshold on networks: define the epidemic threshold, discuss one example among the heterogeneous mean field approximation and the quenched mean field approximation
- 12) Activity driven model for temporal networks: model ingredients, model properties, mathematical formulation
- 13) Metapopulation modelling framework: present the general concept, discuss the case of the Markovian mobility model
- 14) Global invasion threshold: underling concept, key factors affecting the global invasion, mathematical formulation
- 15) Spatial propagation of epidemics in a metapopulation model: statistics of arrival times of the first case in a new patch, effect of travel restrictions