TATM38, Program for seminars, 2023

Chapter, section and problem numbers refer to the course book Edelstein-Keshet. There are 30 seminars, the last three for project presentations. Copies of lecture notes and exercises (with solutions) are available on the course page. Some lecture notes have simple test questions that you should try to answer. Minor modifications during the course are possible.

Sem 1	Modeling with (systems of) first-order ordinary differential equations (ODE's). Exponential and logistic population growth, predator-prey models, epidemic models. [4.1, 6.1-2, 6.6]
Sem 2	Linear and separable ODE's (repetition). Logistic equation without and with fishing term. [4.1, 4.8, Pr 4.5, notes] Recommended: Do test questions on ODE's
Sem 3	Steady states, phase line, stability for single ODE's. Repetition of some linear algebra Linear systems of ODE's. [4.8, 5.1, 6.1, notes] Recommended: Solve exercises 1-3 on time continuous models (1D population models), do test questions on linear algebra
Sem 4	Phase planes for linear systems, classification of cases, stability. [5.7-8] Steady states, linearization and local stability for non-linear systems. [4.7, 4.9] Recommended: Solve exercises 4-11 on time continuous models
Sem 5	The chemostat: equations, steady states, linearization, stability. [4.2-6, 4.10]
Sem 6	From local to global phase-plane picture. Direction fields, nullclines. [5.2-6, 5.9] Recommended: Solve exercises 13-16 on time continuous models
Sem 7	Phase plane for the chemostat, biological interpretations. [5.10, Pr 5.11-13]
Sem 8	Exercises
Sem 9	Predator-prey models. Lotka-Volterra equations and modifications, phase portraits, steady states, stability. [6.2]
Sem 10	Populations in competition. [6.3, Pr 6.15] Epidemic models, introduction. [6.6]
Sem 11	SIS, SIR, SIRS and SEIR epidemic models for spread of infectious diseases. [6.6]
Sem 12	Discrete models. Linear difference equations. Fibonacci's rabbits, model for propagation of annual plants [1.1-2, 1.5-7, Pr 1.14, notes] Recommended: Do test questions on Linear difference equations
Sem 13	Linear systems of difference equations. Model for red blood cell production. [1.3, 1.9, Pr 1.16, notes] Recommended: Solve exercises 1-2 on discrete models
Sem 14	Non-linear (systems of) difference equations. Steady states, linearization, stability. [2.1-2, 2.7, 3.1] Time discrete SIR epidemic model. Recommended: Solve exercises 3-6 on discrete models
Sem 15	Logistic map, fixed points, stable oscillations, bifurcations, chaos. Cobwebs. [2.3-5] Recommended: Solve exercises 7-8 on discrete models
Sem 16	Exercises
Sem 17	Population genetics. [3.6, Pr 3.18-19]
Sem 18	[Pr 3.20]. Age structure of populations, Leslie matrices. [1.10, Pr 1.20] Recommended: Solve exercise 9 on discrete models

Sem 19	Modeling with partial differential equations (PDE's). The conservation and heat/diffusion equations. Fourier, sin- and cos-series [9.2-4, 9:Appendix, notes] Recommended: Do test questions on Fourier, sin- and cos-series.
Sem 20	Solving initial-boundary value problems (IBVP's) with separation of variables and Fourier series. IBVP's with Neumann boundary conditions. [9.8. 9:Appendix] Recommended: Solve exercises 1-2 on PDE models (IBVP's)
Sem 21	IBVP's with non-homogeneous boundary conditions. Diffusion equation with extra terms. IBVP's in two space dimensions. Recommended: Solve exercises 3-6 on PDE models (IBVP's)
Sem 22	Pattern formation (morphogenesis). Aggregation of cellular slime molds. [10.2, 11.1-3]
Sem 23	Chemical basis for morphogenesis. Turing diffusive instability and pattern formation. [11.4-6]
Sem 24	More on Turing diffusive instability. [Pr 11.18] Aggregation in two space dimensions. [Pr 11.6] Recommended: Solve exercises 7-9 on PDE models (Turing pattern formation)
Sem 25	Diffusion driven pattern formation in 2 space dimensions. [11.7-8, Pr 11.19] Recommended: Solve exercise 10 on PDE models (Turing pattern formation)
Sem 26	Exercises
Sem 27	Glycolytic oscillator without and with diffusion, 1D and 2D. [Pr 7.19, 11.15c] Patterns in cellular automata. [11.9]
Sem 28	Presentation of projects
Sem 29	Presentation of projects
Sem 30	Presentation of projects