Topics on exam (not exhaustive!)

Methods to solve coupled ordinary differential equations and to finds roots of nonlinear equations.

Phase-plane and corresponding concepts: null clines; fixed points; limit cycles; bifurcations; linearization; stability via eigenvalues; homoclinic; heteroclinic.

Different types of bifurcations, description and general form: sub/super critical Hopf; Saddle-node of limit cycle; Saddle-node on invariant circle; homoclinic

Application of phase plane analysis to analyze spiking behavior in simple neuron models: leaky integrate-and-fire; resonate-and-fire; Izhikevich; Morris-Lecar; Hodgkin-Huxley

Concept of phase on a limit cycle and methods to assign phase and calculate Phase response curves (PRC)

Phase models for synchrony in networks: phase-locking of one cell; phase-locking of a pair of cells; Kuramoto model for networks

Neural coding & Bayes' rule. Construct $p(r|s)$ from tuning curves and Poisson statistics.

Estimating stimulus values based on population responses: population vector, maximum likelihood (ML), maximum aposteriori (MAP).

Error in estimators: bias, standard deviation, Fisher information. Calculation of Fisher information, quantification of the effect of correlations and the width of tuning functions and distribution of the centroids. Chelaru & Dragoi paper.

Information theory: entropy, mutual information. Bias in the calculation of entropy. Methods to reduce bias: Strong, Panzeri, shuffling.

Nirenberg etc: How do you estimate using information theory the role of correlations in neural coding. Meister comment.

The visual pathway: cell tuning properties, feature maps.

Kohonen map: algorithm, practical aspects, consequences for coding multiple features.

Neural mass/mean-field/firing rate models: derivation. Example two pool network: working memory. Wilson-Cowan model, behavior (amplification, width of activation, oscillations etc).