Program: ***Statistical Physics and Thermodynamics of Macromolecules***

1. Macromolecules Architecture: linear, branched and comb – like chains; models of macromolecules in a continues and discrete space; real and ideal chains **(2)**.

2. Random walks in two and three dimensions: end-to-end distance and radius of gyration **(2)**.

3. Basic models of macromolecules: freely –jointed chain, chain of free rotations, worm – like chain; rotational isomers; Kuhn segment length and end-to-end distance **(2)**.

4. Gaussian chain: central limit theorem and Gaussian distribution for the ideal linear macromolecule; monomers' density fluctuations and the length of correlations; scale invariance; entropic elasticity **(2)**.

5. Chain rigidity: worm – like chain and persistence length; persistence length and Kuhn segment **(2)**.

6. Real macromolecules: effect the short – range interactions; excluded volume; self – avoiding walks; Flory formula and Flory exponent; good and bad solvent regimes **(4)**.

7. Ideal chain under external field: self – consistent field approximation; analogy with Schrцdinger stationary and non – stationary equations; "wave" function and monomers' density; Schrцdinger equation spectrum, free energy, correlation length and monomers' density fluctuations **(4)**.

8. Semiflexible chains: worm-like chain, end – to – end distance, radius of gyration and persistence length **(2)**.

9. Semiflexible chains under constraints: worm-like chain and energy density; worm – like chain puling; Marko and Siggia equation; worm – like chain in confined geometries; Fokker – Plank equation **(5)**.

10. Directed polymers: models; generating function formalism and exact results; rod – to –coil transition; directed models of polymer adsorption **(3)**.

11. Relationships between macromolecules and critical phenomena: phase transition of the second order, magnetic susceptibility and correlation function; the n-vector model; n=0 limit and single chain problem; many chains in a good solvent **(6).**

12. Polymer solutions of linear chains: concentration regimes, self – consistent field approximation; fluctuation theory of polymer solutions: osmotic pressure, blob concept, correlation length, single chain dimensions **(2)**.

13. Thermodynamics of dilute polymer solutions: Flory – Huggins mean – field theory; free energy, chemical potentials and osmotic pressure; spinodal line; phase separation **(4)**.

14. Theory of polymeric globula: macromolecule in external field; Lifshits formula, free energy and volume approximation; surface effects; coil – globule transition **(4)**.

15. Heteropolymers: block – copolymers and random heteropolymers (RHP); microphase separation; disordered systems, replica and constrained annealing methods; freezing transition in RHP **(4)**.

16. Liquid crystalline ordering: Onsager approximation for the semiflexible macromolecules; order parameter and nematic ordering **(4)**.

17. Branched polymers: dimensions of branched chains; chains with quenched and annealed branching; Flory theory and radius of gyration **(4)**.

References:

1. I. Teraoka. *Polymer Solutions: An Introduction to Physical Properties.* John Wiley & Sons (2002).

2. A. Yu. Grosberg, A. R. Khokhlov . *Statistical Physics of Macromolecules.* American Institute of Physics (2002).

3. V. Privman and N. M. Љvrakic. *Directed Models of Polymers, Interfaces, and Clusters: Scaling and Finite-Size Properties.* Springer-Verlag, Berlin (1989).

4. P.-G. de Gennes. *Scaling Concepts in Polymer Physics*. Cornell University Press (1979).

5. M. Rubinstein, R. H. Colby. *Polymer Physics*. Oxford (2003).