LÜTFEN DUYURU TAHTASINA ASINIZ

SABANCI UNIVERSITY
Faculty of Engineering & Natural Sciences - Fall Semestre 2016

PHYS 438/538: Phase Transitions and Renormalization-Group Theory
Correlations, Criticality, Universality, Current Research Topics

First class: Tuesday 27 September		Office	Phone	Office Hour*
Tues 16:40 - 19:30 Room: FENS G015	**A. Nihat Berker**	**Rektörlük**	**216-483-9011**	**Mon 4:30-5:30**

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Problem Session by **Tolga Çağlar**, time and place to be determined.

*Office consultation can also be done on a drop-in basis or by appointment. Do call us!

Students and listeners, from SU and from other Universities, are welcome.
Shuttle services are available from and to Kadıköy and Taksim.

Prerequisite: Elementary statistical mechanics. **If you know (or can quickly look up) what a partition function is and you are interested, you can take the course.**

Students successfully completing the course may be given an original research problem.

MIT class notes by N. Berker will be followed, supplemented by current developments.
Useful references: Statistical Physics of Particles, of Fields by M. Kardar, Cambridge U.P.(2007); H. Nishimori, Statistical Physics of Spin Glasses and Information Processing, Oxford U.P.(2001); Statistical Physics: Statics, Dynamics and Renormalization, L.P. Kadanoff, World Scientific (1999); Principles of Condensed Matter Physics, P.M. Chaikin and T.C. Lubensky, Cambridge U.P.(1997); Phase Transitions and Critical Phenomena, eds. C. Domb, M.S. Green, and J.L. Lebowitz, Academic P.(1972-2004); scientific journal articles will be indicated.

The students will learn the remarkable phenomena occurring at phase transitions that are universally applicable to a wide range of systems, and simple and physically intuitive theory for deriving these phenomena. The dialog between experiment and theory, as well as the rich confluence of the intuitive, phenomenological, approximate, rigorous, and numerical approaches, will be illustrated.

1. Introduction: phase diagrams, thermodynamic limit, critical phenomena, universality.
2. Classical theories: naive mean-field, constructive mean-field, Landau theories; Ginzburg criterion.
3. Ising models and exact results: one dimension; two dimensions; duality; global phase diagrams.
4. Scaling theory of Kadanoff.
5. Exact renormalization-group treatments in one dimension.
6. Approximate renormalization-group treatments in two dimensions.
   Thermodynamic functions and first-order phase transitions.
7. Momentum-space renormalization group: Gaussian model, Landau-Wilson model, ε-expansion.
8. Variational renormalization group; Migdal-Kadanoff transformations. Berker lattices.
9. Dynamics: stochastic models; detailed balance; dynamic universality classes.
10. Superfluidity. Blume-Emery-Griffiths model. Global multicritical phenomena.
11. Surface systems. q-state Potts and Potts-lattice-gas models.
    Exact critical and tricritical exponents. Helicity and reentrance.
12. Chaotic renormalization groups and spin-glass order. Order under frozen disorder and frustration.
    Scale-free and small-world networks. Connection between geometric and thermal properties.
13. Neural networks, simulated annealing, coding-decoding, using phase transition models.
14. Renormalization-group theory of quantum spin and electronic conduction models.
    High Tc superconductivity. Electron-exchange induced antiferromagnetism. Reverse impurity effects on antiferromagnetism and superconductivity..

Grades: midterm 25%; final 25%; weekly quizzes 25%; homework 25%.
If your homework average is at least 50/100, the lowest two quiz grades will be thrown out.