# Diploma Course in Condensed Matter Physics 2012-13

**Many-Body Phenomenology -** {16 Lectures = 18 hours}

M. Kiselev

## Syllabus:

1. Fermions (4 lectures ) Ideal Fermi gas. Thermodynamics. Pauli paramagnetism. Landau diamagnetism. Fermi liquid. Quasiparticles. Life time of quasiparticles.

2. Bosons (3 lectures) Ideal Bose gas. Thermodynamics. Bose-Einstein Condensation. Weakly interacting Bose-gas. Gross-Pitaevskii equation. Phonons. Goldstone theorem. Superfluidity. Vortices. Ultra-cold atomic gases in traps and optical lattices.

3. Superconductivity (4 lectures). London equations. Electron-phonon interaction. Cooper instability. Bardeen-Cooper-Schrieffer theory. Ginzburg-Landau theory. Thermodynamics and electrodynamics of superconductors. Type 1 and type 2 superconductors. High-temperature superconductivity.

4. Local magnetism (4 lectures). Phenomenological theory of local magnetism. Weiss molecular field. Langevin and Brillouin functions. Ground state. Spin susceptibility. Random Phase Approximation for magnetic systems. Correlation length. Long-range order. Spin dynamics. Bloch equation. Transverse and longitudinal relaxation times. Kondo effect. Magnetism of strongly correlated systems.

5. Nanostructures (1 lecture). Quantum dots and quantum wires. Coulomb blockade. Tunneling and co-tunneling. Coherence and de-coherence. Quantum transport. Molecular electronics.

## Recommended literature:


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| 1 | C.Kittel. Quantum Theory of Solids.(John Wiley and Sons, New York 1987) |
| 2 | J. M. Ziman. Principles of the Theory of Solids. (Cambridge University Press, Cambridge, 1979) |
| 3 | R. White. Quantum Theory of Magnetism. (Springer-Verlag, 1983) |
| 4 | R. Schrieffer. Theory of Superconductivity (Westview Press, 1971) |
| 5 | M. Tinkham, *Introduction to superconductivity*, (Mc- Graw Hill, New York. 1996) |
| 6 | N.W.Ashkroft and N.D. Mermin. Solid State Physics. (Holt, Rinehart and Winston, New York 1976) |
| 7 | A. Abrikosov. Fundamentals of the Theory of Metals (North-Holland, Amsterdam, 1988) |
| 8 | G.Mahan, Many-Particle Physics (Plenum press, NY 1993) |
| 9 | A. Auerbach. Interacting Electrons and Quantum Magnetism. (Springer-Verlag,1994) |