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Graduate Program in Physics
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Solid state physics and field theory applications to condensed matter problems

Course code: FSC3350000

Credit hours: 4

Duration: 18 weeks

DESCRIPTION: Adiabatic theory of solids. Effects of the vibrations of the lattice. Theory of many body problems. Electron-electron interaction. Hubbard model. Electronphonon interaction. Interacting bosons systems. Theory of superfluidity. Phenomenological description of superconductivity. BCS theory. Type I and type II superconductivity. Macroscopic description of superconductivity.

COURSE CONTENT:

1. Physics of the solid state: Free electron theory of solids. Electrons in a periodic potential. Bloch theorem. Lattice vibrations effects. Classical and quantum description of solids. Electron-electron interaction. Electron-phonon interaction. Hubbard model. Exchange interaction. Heisenberg Model. Models for quantum magnetism.

2. Systems of interacting bosons: Equivalent representations of the partition function of interacting bosons systems. Bosons gas weakly interacting. Ground state of a system of interacting bosons. Condensation and superfluidity. Description of the solid-superfluid transition.

3. Fermions systems: Ginzburg-Landau theory of superconductivity. BCS theory. London equations. Type I and type II superconductivity. Vortices in superconductors. Many body vortices system phenomenology in type II superconductors.

BIBLIOGRAPHY:

1. Quantum Field Theory Approach To Condensed Matter Physics. Eduardo Marino. Cambridge University Press. UK (2017).
2. A Modern Approach To Critical Phenomena. Igor Herbut. Cambridge University Press. UK (2007).
3. Quantum Field Theory and Condensed Matter: an introduction. R. Shankar. Cambridge University Press. UK (2017).
4. Superconductivity, Superfluids and Condensates. James F. Annett. Oxford University Press. UK (2004).
5. https://www.if.ufrgs.br/~magusmao/FIP10601/
6. https://www.if.ufrgs.br/~magusmao/FIP10604/