This course will cover selected topics in condensed matter physics. The only pre-requisite is a good knowledge of quantum mechanics- a field theoretical background is not necessary. The following is a rough description of the course (which has been modified from the initial version); please note that this is a preliminary version, and it may be modified depending on the interests of the class:

(i) **Effective Hamiltonians**: All Hamiltonians are effective. The renormalisation group philosophy, and simple techniques (perturbation, Born-Oppenheimer). Examples: $H$ in a box, He-3, metals, semiconductors, impurities, qubits. Quantum phases, in Hamiltonian space, and elsewhere- the Berry and Aharonov-Bohm phases.

(ii) **Basic methods**: Second quantization for fermions and bosons. 1-particle Green functions, self-energy, etc., for fermions. ”Diagrammar”, and some diagrammatic approximations (Hartree-Fock, RPA, etc). Partition function and Green function written as a path integral; simple path integral for an oscillator, and for a spin, and some simple approximations.

(iii) **Strongly-correlated fermions**: Energy scales in a solid- the Anderson lattice, Hubbard, and $t – J$ Hamiltonians. Trial wave-functions (Gutzwiller, etc). Two-site solution, and the $H$ molecule. Phenomenology of the Hubbard model. One dimensional results-Bethe ansatz, and the Luttinger liquid phenomenology. Spin-charge separation. The metal-insulator transition. Some modern approaches- lattice gauge theories, flux phases and the Hofstadter model, etc.


If there is time:

(iv) **Topological Liquids** The Fractional Quantum Hall effect (FQHE); Laughlin states, quasiparticle and magnetoroton excitations, and anyons. Composite fermion and composite boson models of FQHE. Anyone on a lattice- Hofstadter model. General theory of topological liquids.