

Discuss one of the following subjects at your choice, giving a detailed treatment of the concrete examples involved.

- 1) Summarize the most important results of the spectral theory of operators in Hilbert spaces. Give concrete examples in the case of symmetric, selfadjoint and unitary operators of physical relevance.
- 2) Discuss the relations between the Hamiltonian and the Lagrangian formalisms in classical mechanics. Give an example in which there is full equivalence between the two set ups and one in which problems arise.
- 3) Describe the realization of the lie algebra of the Euclidean group on R^3 in terms of
 - a) generating functions of the induced infinitesimal canonical transformations in hamiltonian mechanics,
 - b) operators in $\mathcal{L}^2(R^3)$ in quantum mechanics.
- 4) Describe the variational formulation of the Maxwell equation in vacuum. Discuss their invariance properties under:
 - a) the Galilei and the Lorentz groups,
 - b) The group of gauge transformations.