1. Adding to the Lagrangian the term

$$-\frac{1}{2\alpha}\left(n_\mu A^\mu\right)^2$$

which fixes the axial gauge, derive formula (5.3.16) for the propagator.
Hint: In addition to the lectures the literature might be also helpful (e.g. Bailin and Love, around eq. (10.57)).

2. By choosing appropriately the vector n_μ derive from the propagator in the axial gauge the propagator in the

   a) Hamilton gauge
   b) Coulomb gauge
   c) Landau gauge
   d) Feynman gauge.

3. Derive, using the path integral formalism, the Feynman rules for a scalar theory with a Lagrangian

$$\mathcal{L} = \frac{1}{2}\partial_\mu\phi(x)\partial^\mu\phi(x) - \frac{1}{2}m^2\phi(x)^2 - \frac{\lambda}{3!}\phi(x)^3 - \frac{g}{4!}\phi(x)^4.$$

Draw the connected diagrams up to one loop level for the reaction $a+b \to c+d$.
Hint: See Chaichian and Nelipa section 5.2.

4. Show

   a) $\overline{u}(p,s)\gamma^\mu u(p,s') = 2\delta_{ss'}p^\mu$,
   b) $\overline{v}(p,s)u(p,s') = 0$,
   c) $\overline{u}(p,s)\gamma^\mu u(q,s') = \frac{1}{2m}\overline{u}(p)\left[(p+q)^\mu + i\sigma^{\mu\nu}(p-q)_\nu\right]u(q)$ (Gordon decomposition) ,

where s (s') are the helicities of respective spinors.

Hint: See Halzen-Martin (ex. 6.1 and around), or Björken-Drell.

If you have not already done so, please fill in the student survey. Forms can be found from the exercise box or from the web page.

Return the solved problems to the downstairs box in Laurikainen building on Monday November 9th at 12 o'clock at latest. There are two problems solving sessions: Tuesdays 16-18 in the Exercise room (harjoitussali) in the basement of the Laurikainen bldg [English] and Fridays 10-12 in Hall 5, Tallqvist bldg [Finnish].
The www-page of this course is: http://www.physics.helsinki.fi/%7Epuolamak/hitu/