

**Ph634: Advanced Quantum Mechanics / Quantum Field Theory**  
**Problem Set 3: Feynman Diagrams**

- (1) Consider the Klein-Gordon theory with interaction term  $g\phi^3$ , but no  $\phi^4$  interaction.
- (a) Work out the Feynman rules for this theory, both in coordinate and momentum space.
  - (b) Is the number of scalar particles conserved in a scattering process?
  - (c) Draw the Feynman diagrams representing  $2 \rightarrow 2$  particle scattering to order  $g^2$  and relate them to explicit expressions obtained using the Wick expansion.
  - (d) Draw all the vacuum graphs to order  $g^4$ . Work out the integral expression for the order  $g^2$  vacuum graph, checking the Feynman rule result directly against the explicit calculation using the Wick expansion. You need not evaluate this integral.
- (2) Problem 4.2 in Peskin.
- (3) Work carefully through equations (4.50)-(4.53) in Peskin.