

Quantum Field Theory
TAE, Oviedo, September 2009
Problems - 1

1. Compute the path integral formulas for $\langle q_b | e^{-i(t_b - t_a)\hat{H}} | q_a \rangle$,
 - (a) in terms of the Hamiltonian.
 - (b) in terms of the Lagrangian.
2. Find out $\mathcal{Z}[J]$ for the free field theory.
3. Find out $\mathcal{Z}[J]$ for the φ^4 theory.
4. By taking derivatives of $\mathcal{Z}[J]$ with respect to J , find $\mathcal{G}^{(2)}(x_1, x_2)$ for the φ^4 theory up to order λ .
5. By taking derivatives of $iW[J]$ with respect to J , find $G^{(2)}(x_1, x_2)$ and $G^{(4)}(x_1, x_2, x_3, x_4)$ for the φ^4 theory. Also find $G^{(2)}(p, -p)$.
6. Using the Feynman rules for φ^4 , write the amplitude for the 2-particle scattering $(1 + 2 \rightarrow 3 + 4)$ up to order λ^2 (you don't have to perform the integrals).