Problem Set 4 (due Mar 9, 2015)

1. **The interaction picture. Problem 9.5 Srednicki**

2. **Path integrals.**

   (a) Assuming M is a symmetric, positive definite matrix and $q = q_1, \cdots q_n \in R^N$, show that

   $$\int \Pi dq_i e^{-iq^T M(1-i\epsilon)q + iJ^T q + iq^T J} = \sqrt{(\frac{\pi}{i})^n} \frac{1}{\sqrt{\mathrm{detM}(1 - \mathrm{i}\epsilon)}} \tag{1}$$

   (b) Assuming M is a hermitian, positive definite matrix and $q = q_1, \cdots q_n \in C^N$, show that

   $$\int \Pi dq_i^* dq_i e^{-iq^\dagger M(1-i\epsilon)q + iJ^\dagger q + iq^\dagger J} = (\frac{\pi}{i})^n \frac{1}{\mathrm{detM}(1 - \mathrm{i}\epsilon)} \tag{2}$$

   (c) Find

   $$\langle x_f t_f | x_i t_i \rangle \tag{3}$$

   for the Harmonic oscillator. Show that you obtain expected results for $H \to H(1 - i\epsilon)$ and $t_i \to -\infty$ and $t_f \to +\infty$.

   (d) Evaluate

   $$\langle 0\infty | 0 - \infty \rangle \tag{4}$$

   for the scalar field theory in the presence of an external current J.