Quantum Field Theory Homework
A. Zee, *Quantum Field Theory in a Nutshell*

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Problems

I.8.3 For the complex scalar field discussed in the text calculate $\langle 0|T[\varphi(x)\varphi^\dagger(0)]|0\rangle$.

I.8.4 Show that $[Q, \varphi(x)] = -\varphi(x)$.

II.2.1 Use Noether's theorem to derive the conserved current $J^\mu = \bar{\psi}\gamma^\mu\psi$. Calculate $[Q, \psi]$, thus showing that b and $d^\dagger$ must carry the same charge.

III.1.2 Regard (1) as an analytic function of K^2. Show that it has a cut extending from $4m^2$ to infinity. [Hint: If you can't extract this result directly from (1) look at (14). An extensive discussion of this exercise will be given in chapter III.8.]

III.1.3 Change Λ to $e^\epsilon\Lambda$. Show that for $\mathcal{M}$ not to change, to the order indicated λ must change by $\delta\lambda = 6\epsilon C\lambda^2 + O(\lambda^3)$, that is,

$$\Lambda\frac{d\lambda}{d\Lambda} = 6C\lambda^2 + O(\lambda^3)$$