PHY 5669 : Quantum Field Theory B, Spring 2019

January 31^{st} , 2019 Assignment # 1 (due Thursday February 14^{th} , 2019)

1. Consider a massless pseudoscalar Yukawa theory with Lagrangian:

$$\mathcal{L} = \frac{1}{2} \partial^{\mu} \phi \, \partial_{\mu} \phi - \frac{\lambda}{4!} \phi^4 + \bar{\psi}(i\partial \!\!\!/) \psi - ig \bar{\psi} \gamma^5 \psi \phi \,,$$

where ϕ is a real scalar field and ψ is a Dirac fermion field, and compute the β functions (β_{λ} and β_{g}) for the λ and g couplings at the leading order in both λ and g (assume that λ and g^{2} are of the same order). Sketch the coupling constant flows in the $\lambda - g$ plane.

In your QFT A Final Exam you studied the one-loop renormalization of this theory, and you will need to to retrieve those results in order to complete this homework. In particular you will need to retrieve how you defined the renormalized couplings and the expressions of the field and coupling renormalization constants. Please let me know if you need to make a copy of your QFT A Final Exam.

2. Problem 23.1 of Schwartz's book.