

## Physics 332 – Problem Set # 3

(due Wednesday, May 3)

1. Peskin and Schroeder, Problem 12.1.
2. Peskin and Schroeder, Problem 12.2. You should show that, with this  $\beta$  function, the mass  $m_\psi$  of the  $\psi$  field satisfies the Callan-Symanzik equation

$$\left[ M \frac{\partial}{\partial M} + \beta(g) \frac{\partial}{\partial g} \right] m_\psi(g, M) = 0 \quad (1)$$

3. Using the result from the two-loop calculation of the scalar self-energy in  $\phi^4$ -theory that you derived in Problem Set 1 (Peskin and Schroeder, Problem 10.3), show that the Callan-Symanzik  $\gamma$  function in  $\phi^4$ -theory is given by

$$\gamma = \frac{\lambda^2}{12(4\pi)^4} + \mathcal{O}(\lambda^3) \quad (2)$$

Show that, in the  $N$ -component linear sigma model (with its different normalization for  $\lambda$ ),

$$\gamma = (N + 2) \frac{\lambda^2}{(4\pi)^4} + \mathcal{O}(\lambda^3) \quad (3)$$