## Exercises for lectures on BSM physics by Csaba Csaki Days 1-2

**1.** Calculate the leading shift (the quadratically divergent part) in the Higgs mass parameter in the standard model and verify the expression presented in lecture.

**2.** Show that the masses of all particles within a supermultiplet are equal.

**3.** Show that the vacuum energy in SUSY theories is positive definite.

**4.** Show that the effect of a SUSY transformation $e^{i\xi Q+\bar{Q}\bar{\xi}}$ has the effect

$$(x^\mu, \theta, \bar{\theta}) \to (x^\mu + i\theta\sigma^\mu\bar{\xi} - i\xi\sigma^\mu\bar{\theta}, \theta + \xi, \bar{\theta} + \bar{\xi}) \ .$$

**5.** Show that $\bar{D}y$ =0.

**6.** Show that the effect of SUSY transformations on a chiral superfield is

$$\delta\varphi = \sqrt{2}\epsilon\psi, \quad \delta\psi = \sqrt{2}i\sigma^\mu\bar{\epsilon}\partial_\mu\varphi + \sqrt{2}\epsilon F, \quad \delta F = \sqrt{2}i\bar{\epsilon}\bar{\sigma}^\mu\partial_\mu\psi.$$

**7.** Calculate $\int d^4\theta\Phi^\dagger\Phi$.