Exercises for Chapter 6

1. Using

$$m_Q^2 = -\frac{\partial^2 \ln Z}{\partial \ln X \partial \ln X^\dagger}\Big|_{X=M} \frac{F F^\dagger}{M M^\dagger} \ , \tag{1}$$

show that

$$m_Q^2 = 2C_2(r)\frac{\alpha(\mu)^2}{16\pi^2} N \left(\xi^2 + \frac{N}{b}(1-\xi^2)\right)\left(\frac{F}{M}\right)^2 \ , \tag{2}$$

where

$$\xi = \frac{\alpha(M)}{\alpha(\mu)} = \frac{1}{1 + \frac{b}{2\pi}\alpha(\mu)\ln(M/\mu)} \ . \tag{3}$$

For $N = 1$, what value of F/M is required to get a right-handed selectron mass of 100 GeV? Using this value of F/M, estimate the gauge mediation contribution to the running masses (renormalized at 1 TeV) of the left-handed selectron, the right-handed up squark, and the gluino. (Neglect the running of gauge couplings between 90 GeV and 1 TeV.)