This is the first set of exercises on supersymmetry, they present some thinking and some computing: I warmly recommend to try and do both, but if you were stuck, give preference to the thinking aspects. I also ask you to study on your own some little subject I did have time to cover (1 and 4), this way we gain some time.

1. Study $R$-symmetry (on Sohnius or WB)

2. Consider a model with one chiral superfield $\phi$ (that is a Wess-Zumino model): how many real parameters describe the most general renormalizable lagrangian? (use field redef.) Compute the supercurrent and show it is conserved on shell.

3. Consider a model with one chiral superfield with superpotential $W(\phi) = M^2\phi$ and Kahler potential of the form $K(\phi, \phi^\dagger) = f(\phi\phi^\dagger)$ with $f(x)$ a generic function. Compute the lagrangian by eliminating the auxilliary field. What properties you think the function $f$ should satisfy for the above theory to make sense? Indicate by $\varphi$ the scalar component of the supermultiplet. Working around $\langle \varphi \rangle = 0$ and expanding the Kahler potential as

$$K(\phi, \phi^\dagger) = \phi\phi^\dagger + \frac{a}{M^2}(\phi\phi^\dagger)^2 + \frac{b}{M^4}(\phi\phi^\dagger)^3 + \cdots$$  \quad (0.1)

discuss what is going on and compute the mass spectrum. (You can view the above model as one that describes the low energy dynamics of a field composite at the scale $M$, if all parameters are order one then there is no perturbative expansion...don’t worry!)

4. Consider a vector superfield $V$. What does the lagrangian below describe?

$$\frac{1}{4} \{ [W^a W_a]^F + \text{h.c.} \} + \frac{1}{2} m^2 [V^2]_D$$  \quad (0.2)