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 ϕ (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 φ the scalar component of the supermultiplet. Working around $\langle\varphi\rangle = 0$ and expanding the Kahler potential as

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

   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?

$$\frac{1}{4}\left\{[W^\alpha W_\alpha]_F + \text{h.c.}\right\} + \frac{1}{2}m^2\left[V^2\right]_D \tag{0.2}$$