1. Derive the change in density of states for a common metal when the Fermi energy is changed by factor of 1.1×10^{-6}. State any assumptions.
2. For the case of arbitrary variation of doping concentration in a semiconductor crystal, prove that equilibrium can be achieved by migration of negligible amount of charges. (*Hint:* derive a relation between charge carrier concentration and respect to donor or acceptor density)

Questions 3-11 are primarily based on discussions in D. M. Smyth book.

3. Consider doping a metal oxide XO with Y_2O. Write two possible defect reactions for this alloying process.
4. Write down a reaction in the scenario where the host cation acts as interstitial defect.
5. Now consider a donor impurity being added to the host. Write down possible defect reactions involving either a cation vacancy or anion interstitial.
6. Now consider both intrinsic and extrinsic regimes for donor-doped host crystal. Write down the likely charge neutrality conditions for these two cases.
7. Show a plot of defect concentration vs donor concentration based on the above points.
8. Now, let us begin to discuss electronic compensation. For a donor dopant compensated by oxygen interstitials, write down a possible defect reaction.
9. Write down defect reaction for the case of acceptor dopant compensated by holes for the case of high oxygen activity.
10. Write down the set of equilibria for the continuum of non-stoichiometric compositions and the charge neutrality equation.
11. Consider a Kroger-Vink diagram shown below for the case of binary oxide doped with sesquioxide. Under what conditions does the diagram show characteristics of a pure compound?