Device Simulation Laboratory
(EE534P)
Problem sheet 10

Q.1: Take an abrupt Si PN diode with equal doping on both sides, i.e. $N_a = N_d = 10^{17}$ cm^{-3}. Take the lengths of N & P regions to be equal to 5 μm and the width also equal to 5 μm. Plot the IV characteristics of the device for a voltage range of -5 V to 1 V in the linear as well as log scale. Plot the energy band diagrams, carrier concentrations and electron and hole components of the currents for different voltages, namely -1 V, 0 V, 0.2 V and 1 V.
i) Note the reverse saturation current, compare it with what you expect theoretically? Note the slope of log(I) vs V in different regions in forward bias and compare it with what you expect theoretically?
(ii) Repeat part (i) for reduced values of carrier lifetime. You may reduce the values by 10 times & 100 times. What do you observe?
Use models.par for changing the parameters.

Q.2: For the diode mentioned in Q.1, perform breakdown analysis for 3 different values of doping concentrations 10^{16} cm^{-3}, 10^{17} cm^{-3} and 10^{18} cm^{-3}. Also check V_{BR} vs doping, where V_{BR} is approximate breakdown voltage. Take proper meshing in each region and Si diode.

Q.3: For the diode mentioned in Q.1, plot the CV characteristics in reverse bias for 0 to -10 V, use a low frequency of 1 KHz. Also plot $1/C^2$ vs the applied voltage and estimate doping from it. Compare it with the value used while defining the device structure. Also plot the CV characteristics in forward bias (0 to 0.7V). Note the value of the capacitance at 0.5 V from the CV plot. Compare this value with what you expect theoretically.