# Examples of problems given in the Preliminary Examination EECS170A

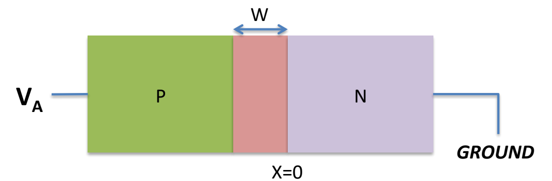
**Note that these are just some examples. Completely different problems may be given.**

**PLEASE USE FOLLOWING GENERAL PARAMETERS UNLESS STATED OTHERWISE:**

$kT = 0.026eV\ @\,300K;\ k = 1.38\times10^{-23}\,J/K;\ h = 6.626\times10^{-34}\,J.s;\ \varepsilon_0 = 8.85\times10^{-14}\,F/cm$

For $Si \rightarrow \quad E_g = 1.12\ eV,\ K_S = 11.7,\ n_i = 10^{10}\,cm^{-3}\ @\,300K,$ For $Ge \rightarrow \quad E_g = 0.66\ eV,\ K_S = 16$

1. Consider an ideal pn junction diode shown in the figure. Doping concentrations for p and n sides are $N_D = 10^{16}\,cm^{-3},\ N_A = 5\times10^{16}\,cm^{-3}$. Also minority carrier lifetimes and diffusion coefficients are given as $\tau_n = 5\times10^{-8}\,s,\ \tau_p = 1\times10^{-8}\,s,\ D_N = 23cm^2/s,\ D_P = 8cm^2/s$. Forward bias voltage of 0.61V is applied. (a) Develop formulation for excess hole concentration as a function of x, x>0, (b) Create an argument and justify your results for calculation of electron and hole diffusion current densities at any point x>0?



2. A MOS capacitor is fabricated by using Metal layer deposited on top of **20nm** thick $SiO_2$ oxide layer on top of p-type silicon with doping concentration of $N_A=1x10^{14}cm^{-3}$. Dielectric coefficients of silicon and oxide layer is given as $K_S=11.8$, $K_O = 3.9$, $\varepsilon_0 = 8.86 \times 10^{-14} F/cm$.
   Draw approximate energy band diagram for following gate voltages. VG = ±0.5V, VG = $\pm V_t$, VG = $\pm 1.5V_t$? (Assume flat band approximation, i.e. metal and semiconductor has same work function)

3. An n-channel MOSFET is connected to a circuit as shown in the figure. For a given $V_{DD}>V_T$, can this MOSFET be in cut off mode for any values of $R_1$ and $R_2$, explain your reasoning? If $R_1/R_2 =1$ estimate and draw the $V_D$ for $V_T<V_{DD}<3V_T$?