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 = 0.026 eV @ 300K; k = 1.38 × 10^{-23} J / K; h = 6.626 × 10^{-34} J.s; \varepsilon_0 = 8.85 × 10^{-14} F / cm

For Si → \Es = 1.12 eV, \KS = 11.7, \ni = 10^{10} cm^{-3} @ 300K, For Ge → \Es = 0.66 eV, \KS = 16

1. Consider an ideal pn junction diode shown in the figure. Doping concentrations for p and n sides are \Nd = 10^{16} cm^{-3}, \NA = 5 × 10^{16} cm^{-3}. Also minority carrier lifetimes and diffusion coefficients are given as \tau_\alpha = 5 × 10^{-8} s, \tau_\rho = 1 × 10^{-8} s, D_\alpha = 23 cm^2 / s, D_\rho = 8 cm^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$_A$=1×10$^{14}$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 = ±V$_t$, VG = ±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 $V_T<V_{DD}<3V_T$?