Problem 1

- i. Ohmic
- ii. Rectifying
- iii. Rectifying
- iv. Ohmic

Problem 2

The divison between are rectifying and ohmic contact occurs when $\Phi_S = \Phi_M$, or equivalently, when the two materials' Fermi levels are identical. Here we assume $\Phi_S = \frac{E_g}{2} + \chi_S$. The difference between the intrinsic Fermi energy and the doped Fermi energy at the transition point:

$$\begin{aligned}\epsilon_f - \epsilon_{fi} &= \frac{E_g}{2} + \chi_S - \Phi_M \\ &= 0.17[eV]\end{aligned}$$

Recalling the dependence of Fermi energy upon doping concentration:

$$\epsilon_f - \epsilon_{fi} = \pm kTln\frac{N_d - N_a}{n_i}$$

Assuming $T = 300K$ and $n_i = 1.5E10[cm^{-3}]$, $N_d - N_a = 1.076E13[cm^{-3}]$. This is the transition concentration.

- i. For n-type $N_d - N_a > 1.076E13[cm^{-3}]$, the contact is ohmic. For n-type $N_d - N_a < 1.076E13[cm^{-3}]$, the contact is rectifying.
- ii. For p-type $N_d - N_a < 1.076E13[cm^{-3}]$, the contact is ohmic. For p-type $N_d - N_a > 1.076E13[cm^{-3}]$, the contact is rectifying.

Problem 3

- i. Diodes
- ii. Field-effect transistors