(a) (10pts) Explain the terms Fermi energy $E_F$ and Fermi temperature $T_F$.

Now consider a 2D semiconductor with parabolic energy bands and electron effective mass $m^*$.

(b) (10pts) Find the number of electronic states in an area $A$ with wavenumber $k$ lower than some absolute value $k_0$. Make sure to consider spin.

(c) (20 pts) The total number of electrons in this 2D semiconductor is given by

$$N = \int_0^\infty \frac{g(E) dE}{e^{(E-\mu)/k_BT} + 1}$$

where $\mu$ is the chemical potential. Find the density of states per unit energy $g(E)$.

(d) (20 pts) Find the chemical potential $\mu$ as a function of the number of electrons per unit area $n \equiv N/A$. A variable substitution may be useful here (e.g. $x = e^{(E-\mu)/k_BT} + 1$ or similar).

(e) (20 pts) Based on the chemical potential in part (d), find the Fermi energy $E_F$.

(f) (20 pts) How does the dependence of the density of states $g(E)$ on energy in 2D parabolic bands (part b) compare with that in 1D and 3D systems? State the expected dependence ($m_1$ and $m_3$) such that

$$g_{1D}(E) \propto (E - E_0)^{m_1}$$

and

$$g_{3D}(E) \propto (E - E_0)^{m_3}$$

Explain your reasoning.