1 (5 pts). What does it mean that a redox system is in dynamic equilibrium?

$$
\begin{align*}
\Delta G &= \Delta G^0 + kT \ln \left( \frac{A}{B} \right) \\
\Delta G^*_f &= \Delta G^0 \pm RT \\
\Delta G^*_D &= \Delta G^0 - (1-x)F(E-E^0)
\end{align*}
$$

2 (5 pts). Briefly explain, using activated complex theory, how the activation barrier for ET can be changed with the applied potential. How do changes in activation barrier height correlate with the rate of a chemical reaction?

3 (5 pts). Sketch the current voltage curves for a redox system at an electrode with rapid kinetics (large k) and sluggish kinetics (small k). How is the current expected to increase with overpotential?
4 (5 pts). What is $k^o$ and how can it be determined?

Rate constant for electrode reaction at $E^o$ or $n = 0$.

Total analysis of $i-E$ curves is a way to determine this:

\[
\text{Slope} = \frac{x_0 F}{2.3RT}
\]

\[
\text{Slope} = \frac{(1-x) x F}{2.3RT}
\]

\[
i_0 = nF A k^o C
\]

For $C_{ox} = C_{red}$

5 (5 pts). Assuming a polarization resistance for a 1 mM solution of Fe$^{3+}$ and Fe$^{2+}$ was measured to be 500 ohm. What are $i_0$ and $k^o$? Assume $A = 1 \text{ cm}^2$. alpha = 0.5. R = 8.314 J/mol-K. T=298 K. F = 96,500 C/mol. \( i_0 = k^o nF A C_{ox}^{(1-\alpha)} C_R^{\alpha} \)

\[
R_{ct} = \frac{RT}{nF i_0}
\]

\[
s_0 = s_0 V_A = \frac{(8.314 (5/288 K) (298K))}{(1)(96,500 \text{ C/mol})}(i_0^0)
\]

\[
\frac{s}{c} = \frac{5}{c} = \frac{5}{c} = \frac{5}{c} = \frac{5}{c} = \frac{5}{c} = \frac{5}{c} = \frac{5}{c} = \frac{5}{c} = \frac{5}{c}
\]

\[
i_0 = 5.1 \times 10^{-3} A = 51 \mu A
\]

\[
C_{ox} = C_R = C = 1 \times 10^{-6} \text{ mol/cm}^3
\]

\[
5.1 \times 10^{-5} \mu s = (1)(96,500 \text{ C/mol})(1 \text{ cm}^2)(k^o)(1 \times 10^{-6} \text{ mol/cm}^3)
\]

\[
k^o = 5.3 \times 10^{-4} \text{ cm/s}
\]