Assignment-3: CEM 403 (UNIT-5) 31/05/2024

1. Deduce the expression for the activity of $\mathrm{Fe(ClO_4)_3}$ in a solution of standard molality m_0 in terms of its mean ionic activity coefficient and the molality of the solution.
2. Write down the fundamental postulate of Debye-Hückel theory. Derive an expression for the charge density associated with the solution of a uni-univalent electrolyte. Mention the assumption(s)/approximation(s) involved in your derivation with appropriate reasoning.
3. Derive an expression for the charge density associated with the solution of any general electrolyte. Mention the assumption(s)/approximation(s) involved in your derivation with appropriate reasoning.
4. Starting from Maxwell's first equation, arrive at the Poisson equation and simplify it for a spherically symmetric charge distribution.
5. Solve the Poisson-Boltzmann equation
$$\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{d\psi}{dr}\right) = \kappa^2\psi$$
to find an expression for the electrostatic potential, $\psi(r)$, at any location $\vec{r}$, due to a central charge and a spherically symmetric charge distribution.
6. The electrostatic potential, $\psi(r)$, at any location $\vec{r}$, due to a central charge and a spherically symmetric charge distribution is given by $\psi(r) = Ae^{-\kappa r}/r$. Use appropriate argument to determine the value of the constant A.
7. What is Debye-Hückel length? Derive an expression for the Debye-Hückel length, given that the ionic atmosphere has a total charge of $-z_i e$.