Topics and Reading Assignments

1. Electrochemical cell -- B&F 2.1, (2.2)
   - Physical description of cell
   - Measure potential
   - Calculate potential
   - Notation for cell, sign conventions
   - Why don't we just "ground the solution?"
   - Galvanic cell
   - Electrolytic cell

2. Charge transfer in a cell / equivalent circuit -- B&F 1.1-1.3
   - Concept of $R_{internal}$ of a cell
   - Physical processes in cell: Eeq, Rct, Rmt, Cedl, Rs, Eappl, V, i
   - Equivalent circuit
   - Application of Kirchhoff's 2nd law to equivaent circuit
     - direction of i
     - resistors
     - battery symbol

   Thermodynamics -- B&F 2.1
   - Reversibility
   - $\Delta G° = -nE°F = - RT \ln K$
   - Sum of E°'s

3. Mass transfer I - R_s (migration only) -- B&F 1.4.1; 2.3.3
   - Nernst Planck equation
   - Derive specific conductivity (κ) from N-P equation
   - Practical conductivity: calculate κ from λ
   - Define transport number, t_i

4. Mass transfer II - R_{mt} (diffusion only, time-dependent solution) -- B&F 1.4.2; 5.2.1
   - Ficks laws
   - Relation of current to flux
   - Semi-infinite boundary conditions
   - Cottrell equation

5. Mass transfer III - R_{mt} (diffusion and advection, steady state solution) -- B&F 1.4.2; 5.1.1; 5.4.3-5.4.4
   - Derivation of I vs E curves
     - R insoluble
     - R initially absent
     - R initially present
   - Significance of i_l, E_{eq}, and $E_{½}$
   - Relation of ss-model to RDE, DME, and stagnant boundary layer (Nernst diffusion layer)

6. Kinetics - R_{ct} - phenomenological approach -- B&F 3.1-3.4; 3.5
   - Observables: overpotential, i vs. E curves
   - Homogeneous kinetics
   - Heterogeneous electochemical kinetics
   - Butler-Volmer equation
   - High overpotentials: Tafel plot
   - Low overpotentials: Rct
   - Combined effects of Rct and Rmt

7. Electric double layer -- B&F 1.2; 13.1-13.3
   - Importance in electroanalytical chemistry: conductometry, polarography, adsorption
   - Experimental data for C, q, γ
   - Gibbs equation to relate C, q, γ
   - Helmholtz model
   - Gouy Chapman model, low potential limiting case and full case
   - Stern model, limiting cases for differential capacitance
   - (Adorption isotherms - linear, Langmuir, Frumkin)

8. Potentiometry -- B&F 2.4, 2.3
   - Overview
   - Noncrystalline
   - Crystalline
   - Calculation of $E^{0'}$ from thermodynamic constants
   - Other: gas, enzyme
   - Examples of diffusion potentials
   - Derivation of Henderson equation
   - pH meter circuit and calibration

9. Voltammetric techniques -- B&F 6.1-6.2; 6.5; 7.3.5; 11.8
   - LSV
   - CV
   - Square wave
   - Stripping

10. Instrumentation -- B&F 1.3.4; 15.1-15.4; 15.6
    - Need for 3-electrode cell
    - Fundamental op-amp circuits
    - Potentiostat

11. Special Topics ...

    - Donnan potential and suspension effect
    - Corrosion
    - Sensors
    - Environmental electrochemistry
    - Fuel cells