

# UNIVERSIDADE PRESBITERIANA MACKENZIE





### **Course Syllabus**

Department/Faculty			
School of Engineering			
<b>Graduate Program</b>			
Materials Engineering and Nanotechnology			
Degree			
Academic Master's	□ Doctorate (PhD)	☐ Professional Master's	
Course Name			
Advanced Electrochemistry			
Professor			
Prof. Dr. Cecília de Carvalho Castro e Silva			
Office hours			
48			

#### **Course Overview**

The course addresses the definitions and fundamental concepts of electrochemistry, including models for the formation of the electrical double layer, charge transfer kinetics, empirical equations such as Butler–Volmer and Tafel, Marcus theory of electron transfer, and various overpotentials (activation, ohmic, and mass transport). It explores faradaic processes at electrode interfaces, experimental methods for studying solid/liquid interfaces and charge transfer kinetics, as well as electrochemical devices for charge storage. The course also covers sensors and biosensors with electrochemical detection.

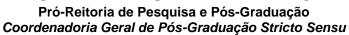
#### **Topics outline**

- 1. Definitions and fundamental concepts;
- 2. Electrochemical interfaces: formation of the electrical double layer (models);
- 3. Charge transfer kinetics; empirical equations: Butler-Volmer and Tafel;
- 4. Marcus theory of electron transfer;
- 5. Overpotentials: activation, ohmic, and mass transport;
- 6. Faradaic processes at electrode interfaces;
- 7. Electrochemical instrumentation (potentiostatic, galvanostatic, and potentiometric techniques);
- Experimental methods for studying the solid/liquid interface and charge transfer kinetics
  (linear and cyclic sweep voltammetry, pulse voltammetric techniques, and electrochemical
  impedance spectroscopy);
- 9. Determination of mechanisms in electrocatalytic reactions;
- 10. Electrochemical devices for charge storage and chemical sensing (basic principles of lithium-ion batteries, supercapacitors, and electrochemical sensors and biosensors).

Classes will include both lectures and laboratory sessions.



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### **Letter Grade Assignment**

Grade A (Excellent) - Grade points between 9 and 10

Grade B (Good) - Grade points between 8 and 8.9

Grade C (Satisfactory) - Grade points between 7 and 7.9

Grade D (Unsatisfactory) - Grade points between 0 and 6.9

### Texts, Materials, and supplies

### Basic bibliography

- COMPTON, R. G.; BANKS, C. E. *Understanding Voltammetry*. 3rd ed. World Scientific Publishing Europe, 2018.
- ELIAZ, N.; GILEADI, E. *Physical Electrochemistry: Fundamentals, Techniques, and Applications.* 2nd ed. John Wiley & Sons, 2019.
- BARD, A. J.; FAULKNER, L. R. *Electrochemical Methods: Fundamentals and Applications*. 2nd ed. New York: Wiley, 2001.
- BRETT, A. M. O.; BRETT, C. M. A. Electroquímica: Princípios, Métodos e Aplicações.
   Coimbra: Almedina, 1996.
- CIUCCI, F. Modelling Electrochemical Impedance Spectroscopy. Current Opinion in Electrochemistry, vol. 3, pp. 132–139, 2019.
- PAJKOSSY, T.; JURCZAKOWSKI, R. *Electrochemical Impedance Spectroscopy in Interfacial Studies. Current Opinion in Electrochemistry*, vol. 1, pp. 53–58, 2017.

### Supplementary Bibliography:

- MEMMING, R. Semiconductor Electrochemistry. 2nd ed. Germany: John Wiley & Sons, 2015.
- Review articles from the current scientific literature.