

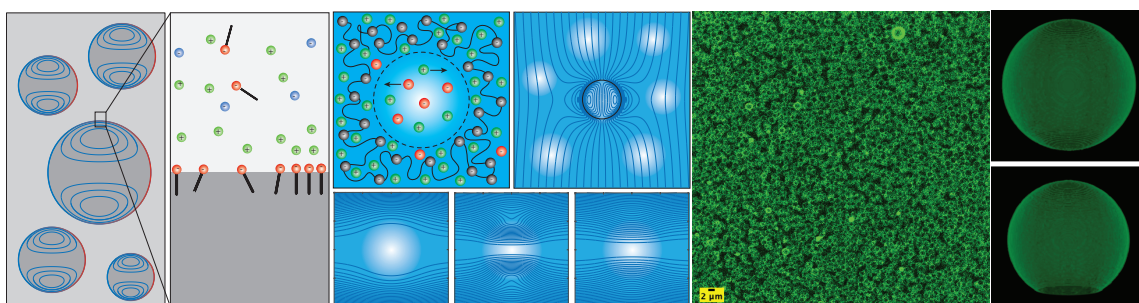
CHEE 585

Foundations of Soft Matter

Winter 2026

Reghan J. Hill

October 14, 2025



©Reghan J. Hill, Soft Matter, McGill University

A “technical elective” accessible to advancing undergraduates and graduates of engineering, chemistry and physics. Delivered at the level of M. Doi’s Soft Matter Physics and/or I. W. Hamley’s Introduction to Soft Matter (depending on the graduate/undergraduate enrolments). The course introduces foundational concepts and methods of analysis to complement phenomenological interpretations of the behaviour of soft materials adopted in contemporary industry and research settings. Each topic is demonstrated in the context of specific materials and accompanying research literature, with extensive worked examples.

Contact: reghan.hill@mcgill.ca

A selection of topics from:

- Binary mixtures. Flory-Huggins model, miscibility, stability, phase separation, micro-structural texture. Cahn-Hilliard model.
- Osmotic pressure, solvent quality, osmotic compressibility, van't Hoff factor and virial expansions.
- Polymer physics. Ideal, freely jointed chains, chain stretching and entropy, mean-field modelling of real chains and polymer brushes.
- Fluctuations, non-Gaussian statistics, and strong stretching of macromolecules.
- Kinematics of deformation, rheological characterization, 'molecular'-inspired modelling of polymer solutions (Maxwell, Rouse and Zimm).
- Kuhn theory of polymer networks (rubbers and hydrogels), swelling and volume transition, shear and axial deformation of swollen hydrogels.
- Poisson-Boltzmann equation, electrostatic screening, Debye-Hückel approximation,
- Electrostatics of macro-ions, Donnan equilibrium.
- Polyelectrolyte hydrogel swelling.
- Interfacial energy, surface-active molecules, surface tension, adsorption isotherms, emulsions.
- Spreading, variational problems, Young-Laplace equation.
- Dispersion forces, van der Waals interactions.
- DLVO theory, and applications to dispersion stability and aggregation.
- Brownian motion and diffusion, Langevin and Fokker-Plank models.
- Non-equilibrium, electrokinetic phenomena, Onsager reciprocity.
- Applications to electrophoresis, streaming potential, and conductivity.