NS 218 Fundamentals of Nanoscience  
Spring 2022

Intended Audience:
A sophomore level hands-on course for MAT, BIO, and ME majors, PHYS minors, or anyone interested in understanding phenomena governing the behavior of structures in the 1-100 nm size range.

Objective:
Throughout the Semester, we will make models to crystallize our thinking ---you know what, actually to start thinking. Via models we will develop intuition and heuristics to come up with conjectures/hypotheses to be tested by experiments (in wet lab and/or in silico). Accordingly, these will provide a helping hand towards having a knowledge base on how man-made nanostructures and biological nanomachines behave. At the end, we will have the insight for junior-senior level courses where both extensive measurements on materials and biological systems on all scales are made, and the formation of higher order structure is discussed.

Moderator: Name: Ali Rana Atılgan  
Office No.: FENS 2093  
Phone No.: +90 (216) 483 9525  
e-mail: atilgan@sabanciuniv.edu  
URL: http://people.sabanciuniv.edu/atilgan

Associate: Dilşah Nur Elmacı dilsahelmaci@sabanciuniv.edu

Course Data:  
Hours/Room: Mon 17.40-19.30; Thu 18.40-19.30/FASS G018  
Office hours: TBA

Textbook:

Reference:

Weeks Commencing/Topics:

Feb 28, Mar 7, and 14  Act I – A story from $1/r$ to $1/r^6$ and empirical energy functions

Entropy as multiplicity and its role in nanoscience
Coulomb’s law and charge interactions
What do we mean by long range and how do they get weaker?
The thermal energy steps on the stage
Dipoles – are they to stay fixed?
Polarizability
Is it a material constant?
Induced dipoles – are they ubiquitously observable?
van der Waals interactions
Hydrogen bonds

Mar 21, 28, and Apr 4  Act II – Then surfaces get into the picture

Forces between particles and surfaces
SFA and AFM – are we getting serious, can we measure these forces?
Hamaker constants
Ions take a role again – they shield charged objects in water
Debye length and Bjerrum length; any other length of similar spirit; would you suggest one?
To what extent it is possible to unify concepts in intermolecular and inter-particle forces?
How do similar surfaces come together in a medium?
Surface and interfacial energy

Apr 11  Review and the Midterm
Apr 18, 25, and May 9  Act III – Interactions lead to binding
(May 2  Spring Break)
Chemical kinetics – A quick recapitulation of NS 10X courses
   The effect of temperature; is this thermal energy again?
   How is it different from physical kinetics?
Binding and Adsorption Processes
   The Langmuir Model – we better recollect our thermodynamics fundamentals
   The Michaelis–Menten Model; yes, another old but not aged model
   Sabatier’s Principle – too many names floating around here! No worries just to shorten the syllabus
   Delicacy – binding should be neither too tight nor too weak

May 16, 23, and 30  Act IV – Multiple agents cooperatively in action

Self-assembly
   Benjamin Franklin spirit
   Amphiphilic molecules – what shapes of micelles do they form and why?
Biological machines
   Are they different from thermodynamic cycles via which macro engines operate?
Time and length scales in the Nano-world
   And “Curtain!”

June 6  Review and the Final

Class Policies
Course will be hybrid.
Zoom link: https://sabanciuniv.zoom.us/j/98348925459

Grading
   Participation: 10% of the final grade
   Midterm: 40% of the final grade
   Final exam: 50% of the final grade; covers all the material
For a passing grade, need to collect 45% before participation added.