Syllabus
物理力学/Physical Mechanics
徐志平 (xuzp@tsinghua.edu.cn)

Lectures: 16 sessions, 3 hours / session
Requirements: solid mechanics, some quantum mechanics and statistical physics
For the in-class practice: laptop, registration for using FIT computational facilities

Texts
[P] Philips, Rob. *Crystals, Defects and Microstructures: Modeling Across Scales*. Cambridge University Press, 2004. ISBN: 9780521793575.
[K] Kittel, Charles. *Introduction to Solid State Physics*, 8th edition. Wiley, 2004. ISBN: 047141526X.

Suggested readings
[M] Martin, Richard. *Electronic Structure: Basic Theory and Practical Methods*, Cambridge University Press, 2008. ISBN: 0521534402.
[BAC] Balluffi, Robert W., Allen, Samuel M. and Craig Carter, W., *Kinetics of Materials. Hoboken*, NJ: J. Wiley & Sons, 2005. ISBN: 9780471246893.
[C] Courtney, Thomas H., *Mechanical Behavior of Materials*, 2nd ed. McGraw-Hill, 2000. ISBN: 0070285942.

Grading
8 bi-weekly assignments
1 final project assignment

Week 1 (11 Sep)
Lecture 01 – H_2O: an introduction
I. Crystalline solids, liquid and gas, amorphous solids, defects

Week 2 and 3 (18, 25 Sep)
Lecture 02 – Structures: the structure-property relationship
I. Crystalline solids
II. Liquid and gas, amorphous solids, defects

Week 4-8 (9, 16, 23, 30 Oct; 6 Nov)
Lecture 03 – The ground state: electrons and phonons
I. Basic quantum mechanics, free electrons
II. From atoms to crystals, the tight-binding methods
III. Electrons, the nearly-free electron model and plane-wave methods
IV. First-principle calculations
V. Phonons, mechanical and thermal properties

Week 9-13 (13, 20, 27 Nov; 4, 11 Dec)
Lecture 04 – Atoms in motion: thermodynamics and statistical mechanics
I. Thermodynamics, the *H*-theorem, molecular dynamics
II. The ensemble theory, Monte-Carlo
III. Transition state theory, kinetic Monte-Carlo, free-energy methods
IV. Transport behaviors & correlation functions
V. Phase transition and lattice models
VI. Polymers, membranes and networks

Week 14-16 (17, 24, 31 Dec)
Lecture 05 – The ultimate material: mechanics of materials
I. Defects & microstructures
II. Materials aging
III. Interfaces and surfaces
IV. Friction and wear