Syllabus: Physical Kinetics.

University of Puerto Rico
Río Piedras Campus
College of Natural Sciences
Department of Physics

Title: Physical Kinetics
Code: PHYS-8996
Prof. Vladimir Makarov

Number of Credits: 3
Prerequisites: Permission of the Graduate Committee
January 2017

Description

Physical Kinetics. Development of the basic formalism including the various representations and 'pictures' of Physical Kinetics. Liquid and solid Physical Kinetics processes will be discussed and basic statements of Physical Kinetics will be presented. Basis approach developed in Physical Kinetics will be considered and applied to analysis of different physical systems. Application of Physical Kinetics methods to analysis physical properties and development of a new physical devices.

Objectives

Through this course, the students will:

- Acquire a basic understanding of the laws of Physical Kinetics.
- Become proficient with the mathematical formalism and basic physical statements of Physical Kinetics.
- Develop problem-solving skills and strategies in basic Physical Kinetics in Physics, Chemistry and Biology.
- Communicate effectively a topic pertinent to basic Physical Kinetics in Physics, Chemistry and Biology

Course Contents and Time Distribution

I. Introduction (2 wks)

a) Brief discussion of Physical Kinetics problems;

b) Basic statements of Physical Kinetics;

c) Brief introduction to gas kinetics theory as example of physical kinetics processes.

II. The diffusion approximation (2 wks)

a) Fokker-Plank equation;

b) A weakly ionized gas in an electric field;

c) Fluctuations in a weakly ionized gas;

d) Recombination and ionization;

e) Ambipolar diffusion;

f) Ion mobility in solution of strong electrolyte.

III. Instability theory (2 wks)

a) Beam instability;

b) Absolute and convective instability;

c) Amplification and non-transparency;

d) Instability with weak coupling of the two branches of the oscillating spectrum;

e) Instability in a finite systems.

IV. Insulator (2 wks)

a) Interaction of phonons;

b) The transport equation for phonon in insulator;

c) Thermal conduction in insulator. High temperature limit;

d) Thermal conduction in insulator. Low temperature limit;

e) Phonon scattering by impurities;

f) Phonon gas dynamics in insulators.

g) Sound absorption in insulator. Long waves;

h) Sound absorption in insulator. Short waves;

V. Quantum liquids (2 wks)

a) Transport of quasi-particles in Fermi liquids;

b) Thermal conductivity and viscosity of Fermi liquids;

c) Sound absorption in Fermi liquids;

d) Transport equation for quasi-particles in Bose liquids.

VI. Metals (3 wks)

a) Residual resistance;

b) Electron-phonon interaction;

c) Transport coefficients in metal. High temperature;

d) Umklapp processes in metal;

e) Transport coefficients in metal. Low temperature;

f) Electron diffusion on the Fermi surface;

g) Galvanometric phenomena in strong field. General theory;

h) Galvanometric phenomena in strong field. Particular cases;

i) Anomalous skin effects;

j) Skin effects in IR range;

k) Helicon waves in metals;

l) Magnetoplasma in metals;

m) Quantum oscillators of the conductivity of metals in magnetic field.

VII. Kinetics of the phase transitions (2 wks)

a) Kinetics of the first order phase transitions. Nucleation;

b) Kinetics of the first order phase transitions. Coalescence;

c) Relaxation of the of the order parameter near a second order phase transition;

d) Dynamical scale invariance;

e) Relaxation in liquid helium near the λ-point

VIII. Dynamics of the radiationless processes (2 wks)

a) Irreversible radiationless processes;

b) Reversible radiationless processes.

IX. Basis of physical kinetics application to biophysical processes (2 wks)

Instructional Strategies
Lectures, problem sets, group discussions, and oral presentations by the students.

Minimum Required Facilities
Traditional lecture room

Student Evaluation
Two partial exams, 3 homework assignments, and oral presentation

Grading System

Standard A to F grading system:
100-90% = A, 89-80% = B, 79-70% = C, 69-60% = D, 59-0% = F.

Bibliography

E.M. Liffshits, L.D. Landau, Physical kinetics, Butterworth- Heineman, 1997.

Online Resources:

http://www.phy.pku.edu.cn/~fusion/down/Dia/NewBook.pdf
http://www.gbv.de/dms/ilmenau/toc/775988952.PDF
http://e-collection.library.ethz.ch/eserv/eth:48295/eth-48295-02.pdf

Rights of Students with Disabilities

UPR complies with all federal and state laws and regulations regarding discrimination, including the Americans with Disabilities Act 1990 (ADA) and the Commonwealth of Puerto Rico Law 51. Students receiving services through Rehabilitación Vocational must contact the professor at the beginning of the semester in order to plan for a reasonable accommodation and any required support equipment according to the recommendations given by the Oficina de Asuntos para las Personas con Impedimentos (OAPI) of the Dean of Students. Likewise, students with special needs that require some type of accommodation must contact the professor.