ANALYTICAL MECHANICS (PHY 600)

Instructor: Prof. Bogdan Dabrowski, Physics Department, NIU. You can find me in my office (La Tourette Hall 216; phone: 815-753-6474) or in my labs La Tourette Hall 215 and FR 110 (phone: 815-753-6472) on Mondays, Tuesdays, Wednesdays and Fridays. You can also reach me on Thursdays at Argonne National Laboratory (phone: 630-252-5541) or at email dabrowski@anl.gov.

Course meeting time and place: 11:00 AM– 12:15 PM on MW at La Tourette Hall 237.

Office hours: on Mondays and Wednesdays from 4:00 to 5:00 PM at La Tourette Hall 216.

The required textbook: *Classical Mechanics (3rd edition)* — Herbert Goldstein, Charles P. Poole, and John L. Safko (Addison Wesley, 2001, ISBN-10: 0201657023, ISBN-13: 978-0201657029)

Topics and chapters we will study:
Ch. 1.1 – 1.6: **Elementary principles and equations of motion from the variational principles**
Generalized coordinates
The principle of least action
The Euler-Lagrange equations of motion
Ch. 2.1 – 2.7 and Ch. 8.1 – 8.2, 8.5: **Variational principles and the Lagrange's and Hamilton equations of motion**
The relation between the Lagrangian and the Hamiltonian descriptions
Constraints
Symmetries and conservation laws
Ch. 3.1 – 3.10: **The central force problem**
The equivalent one-dimensional problem
Classification of orbits
The virial theorem
Differential equations of the orbit
The Kepler problem: the inverse-square law of force
Scattering in a central force field
Ch. 4.1 – 4.10 and Ch. 5.1 – 5.6: **Rigid body motion**
Coordinate transformation under rotation
Orthogonal transformations
The equations of motion
Angular momentum of a rigid body
Ch. 6.1 – 6.5: **Small oscillations**
The equations of motion
Normal modes
Forced vibrations
Damped oscillations
Ch. 7.1 – 7.5, 7.9, 8.4: **Special relativity**
From Galilean to Lorentz transformation of space-time
Covariant formulation of special relativity - the Minkowski metric tensor
the Poincaré group and its algebra
Relativistic adaptation of Hamiltonian and Lagrangian dynamics

Ch. 9.1 – 9.6: **Invariance properties of the Lagrangian and Hamiltonian descriptions**
Poisson brackets
Canonical transformations
Group properties and methods of constructing canonical transformations
Ch. 11.1 – 11.6: **Stability and chaos**
Final Exam (Wed. December 11, 10:00-11:50 a.m.)

There will be several problems solved in class for every chapter we study. Additional problems will be assigned as homework. I will collect and grade these problems the following week – there is no substitute for solving problems on your own. Your work must be based on honesty. The attempt of any student to present as his or her own work that which he or she has not produced will be regarded as a serious offense.
There will be closed-books final comprehensive exam.

The grades will be based on the total amount of points you would accumulate during the course (homework 50% and final exam 50%):

A (4.00)	90 – 100%
A- (3.67)	80 – 89 %
B+ (3.33)	72 – 79%
B (3.00)	64 – 71%
B- (2.67)	56 - 63%
C+ (2.33)	48 – 55%
C (2.00)	40 – 47%
C- (1.50)	35 – 39%
D (1.00)	30 – 34%
F (0.00)	29% or less