Course: Classical Mechanics
Physics 521, Fall 2013
M,W,F: 10:10 - 11:00, Swain West 218

Instructor: Radovan Dermisek
email: dermisek@indiana.edu
office: Swain West 225
office hours: when I am in and by appointment
phone: (812) 856 6918
website: http://www.physics.indiana.edu/~dermisek/
Text: A.L. Fetter and J.D. Walecka, Theoretical Mechanics of Particles and Continua

Chapters: 1-6 in detail; others time permitting

Other useful books:

L.D. Landau and E.M. Lifshitz, Mechanics
H. Goldstein, C.P. Poole and J.L. Safko, Classical Mechanics
J.R. Taylor, Classical Mechanics (undergrad level)
Chapter 1  Basic Principles
  1  Newton’s Laws
     Statement of Newton’s Laws
     Conservation Laws
  2  Systems of Particles
     Center-of-Mass Motion
     Angular Momentum
     Energy
  3  Central Forces
     Conservation Laws
     Effective Potential
     Inverse-Square Force: Kepler’s Laws
  4  Two-Body Motion with a Central Potential
  5  Scattering
     Hyperbolic Orbits in Gravitational Potential
     General Scattering Orbits
     Cross Section
     Rutherford Scattering
     Scattering by a Hard Sphere

Chapter 2  Accelerated Coordinate Systems
  6  Rotating Coordinate Systems
  7  Infinitesimal Rotations
  8  Accelerations
  9  Translations and Rotations
10  Newton’s Laws in Accelerated Coordinate Systems
11  Motion on the Surface of the Earth
     Particle on a Scale
     Falling Particle
     Horizontal Motion
12  Foucault Pendulum
Chapter 3  Lagrangian Dynamics
   13  Constrained Motion and Generalized Coordinates
       Constraints
       Generalized Coordinates
       Virtual Displacements
   14  D’Alembert’s Principle
   15  Lagrange’s Equations
   16  Examples
       Pendulum
       bead on a Rotating Wire Hoop
   17  Calculus of Variations
   18  Hamilton’s Principle
   19  Forces of Constraint
       Pendulum
       Atwood’s Machine
       One Cylinder Rolling on Another
   20  Generalized Momenta and the Hamiltonian
       Symmetry Principles and Conserved Quantities
       The Hamiltonian

Chapter 4  Small Oscillations
   21  Formulation
   22  Normal Modes
       Simplest Case
       Coupled Problem: Formulation
       Linear Equations: A Review
       Coupled Problem: Eigenvectors and Eigenvalues
       Coupled Problem: General Solution
       Matrix Notation
       Modal Matrix
       Normal Coordinates
   23  Example: Coupled Pendulums
   24  Example: Many Degrees of Freedom
       Two N-Body Problems
       Normal Modes
   25  Transition from Discrete to Continuous Systems
       Passage to the Continuum Limit
       Direct Treatment of a Continuous String
       General Solution to the Wave Equation with Specified Initial Conditions
       Lagrangian for a Continuous String
       Normal Coordinates
       Hamilton’s Principle for Continuous Systems
Chapter 5  Rigid Bodies
   26  General Theory
       Motion with One Arbitrary Fixed Point
       General Motion with No Fixed Point
       Inertia Tensor
       Principal Axes
   27  Euler’s Equations
   28  Applications
       Compound Pendulum: Kater’s Pendulum and the Center of Percussion
       Rolling and Sliding Billiard Ball
       Torque-free Motion: Symmetric Top
       Torque-free Motion: Asymmetric Top
   29  Euler Angles
   30  Symmetric Top: Torque-free Motion
       Equations of Motion and First Integrals
       Description of Motion in Inertial Frame
   31  Symmetric Top: One Fixed Point in a Gravitational Field
       Dynamical Equations
       Effective Potential
       Small Oscillations about Steady Motion

Chapter 6  Hamiltonian Dynamics
   32  Hamilton’s Equations
       Review of Lagrangian Dynamics
       Hamiltonian Dynamics
       Derivation of Hamilton’s Equations from a Modified Hamilton’s Principle
   33  Example: Charged Particle in an Electromagnetic Field
   34  Canonical Transformations
   35  Hamilton-Jacobi Theory
   36  Action-Angle Variables
   37  Poisson Brackets
       Basic Formulation
       Transition to Quantum Mechanics
Notes: available on my website.

Homework: there will be assignments about every week. Unless specified otherwise, they will be due exactly one week after they are assigned (typically on Wednesdays).

Late Assignments: Start work early on the assignment. No late homework will be accepted without my prior consent.

Grader: TBD

office: Swain West TBD

email: tbd@indiana.edu
Exams: there will be two exams: a midterm exam and a final exam. The final exam will cover all material presented in lecture, discussed in the text, or included in the homework problems.

Grades: the course grade will be weighted as follows:
- homework = 50%,
- midterm exam = 25%,
- final exam = 25%.
Letter grades will not be assigned to the exams or the homework.
Advice: work hard from the first day; study till you can derive every single formula; think about the meaning of equations you are deriving; think about applications; solve as many problems as possible.

Attendance: optional but highly recommended.

Academic honesty: I encourage you to discuss physics with your colleagues. It is an excellent way to learn. You can also discuss homework assignments with others in the class. However you are expected to write your own solutions!

Have Fun!!!