NIU PHYS 600 - Classical Mechanics, Fall 2015

Course web page: http://nicadd.niu.edu/~dhiman/courses/phys600_15/

Course syllabus

1. **Introduction to group theory (lecture notes)**
2. **Equations of motion from the variational principles**
   - Generalized coordinates
   - The principle of least action
   - The Lagrangian and the Euler-Lagrange equations of motion
3. **The Hamilton and Weiss variational principles**
   - Hamilton's principle of least action
   - Weiss' action principle and the Hamiltonian
4. **The relation between the Lagrangian and the Hamiltonian descriptions**
   - Hamilton's equations of motion
   - Equivalence of the Lagrangian and Hamiltonian descriptions
5. **Symmetries and conservation laws**
   - Homogeneity of time and conservation of energy
   - Homogeneity of space and conservation of linear momentum
   - Isotropy of space and conservation of angular momentum
   - A more general treatment of the conservation laws and the action principle
   - Constraints
6. **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

7. **Rigid body motion**
    - Coordinate transformation under rotation
    - Orthogonal transformations
    - The equations of motion
    - Angular momentum of a rigid body
    - The symmetrical top
8. **Small oscillations**
    - The equations of motion
    - Normal modes
    - Forced vibrations
    - Damped oscillations
9. **Invariance properties of the Lagrangian and Hamiltonian descriptions**
    - Poisson and Lagrange brackets
    - Canonical transformations
    - Group properties and methods of constructing canonical transformations
10. **Special relativity (lecture notes)**
    - 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