

Module Code: MATH-410  
Module Title: **Analytical Dynamics**  
Module Rating: 3 Cr. Hours

### **Lagrange's Theory of Holonomic Systems**

- Generalized coordinates
- Holonomic and non-holonomic systems
- D'Alembert's principle, d-delta rule
- Lagrange equations
- Generalization of Lagrange equations
- Quasi-coordinates
- Lagrange equations in quasi-coordinates
- First integrals of Lagrange equations of motion
- Energy integral

### **Hamilton's Theory**

- Hamilton's principle
- Generalized momenta and phase space
- Hamilton's equations
- Ignorable coordinates, Routhian function
- Derivation of Hamilton's equations from a variational principle
- The principle of least action

### **Lagrange's Theory of Non-Holonomic Systems**

- Lagrange equations for non-holonomic systems with and without Lagrange multipliers
- Hamilton's Principle for non-holonomic systems

### **Canonical Transformations**


- The equations of canonical transformations
- Examples of canonical transformations
- The Lagrange and Poisson brackets
- Equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation

### **Hamilton-Jacobi Theory**

- The Hamilton-Jacobi equation for Hamilton's principal function
- The harmonic oscillator problem as an example of the Hamilton-Jacobi method
- The Hamilton-Jacobi equation for Hamilton's characteristic function
- Separation of variables in the Hamilton-Jacobi equation

### **Recommended Books**

1. D. T. Greenwood, *Classical Dynamics* (Dover, 1997).
2. F. Chorlton, *Chorlton Text Book of Dynamics* (Ellis Horwood, 1983).
3. H. Goldstein, C. P. Poole and J. L. Safko, *Classical Mechanics* (Addison-Wesley Publishing Co., 2003).
4. S. D. Lindenbaum, *Analytical Dynamics: Course Notes* (World Scientific, 1994).
5. E. J. Saletan and J. V. José, *Classical Dynamics: A Contemporary Approach* (Cambridge, 1998).
6. J. B. Marion and S. T. Thornton, *Classical Dynamics of Particles and Systems* (Thomson Learning, 2003).

  
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