Dynamics and Relativity

Basic concepts

Space and time, frames of reference, Galilean transformations. Newton's laws. Dimensional analysis. Examples of forces, including gravity, friction and Lorentz

Newtonian dynamics of a single particle

Equation of motion in Cartesian and plane polar coordinates. Work, conservative forces and potential energy, motion and the shape of the potential energy function; Stable equilibria and small oscillations; effect of damping

Angular velocity, angular momentum, torque

Orbits; the $u(\theta)$ equation; escape velocity; Kepler's laws; Stability of orbits; motion in a repulsive potential (Rutherford scattering)

Rotating frames: centrifugal and Coriolis forces.
* Brief discussion of Foucault pendulum*

~~Newtonian dynamics of system of particles~~ (Rigid bodie

Momentum, angular momentum and energy of a rigid body. Parallel axis theorem. Simple examples of motion involving both rotation and translation (eg rolling)

~~Rigid bodies~~ (Newtonian dynamics of system of particles)

~~Moments of inertia, angular momentum and energy of a rigid body.~~ Momentum, angular momentum and energy. Motion relative to the ~~mass~~ centre of mass; the two-body problem. Variable mass problems; the rocket equation.

Special relativity

The principle of relativity. Relativity and simultaneity. The invariant interval. Lorentz transformations in (1+1)-dimensional spacetime. Time dilation and length contraction. The Minkowski metric for (1+1)-dimensional spacetime.

Lorentz transformations in (3+1) ~~dimensional~~ dimensions. 4-vectors and Lorentz invariants. Proper time. 4-velocity and 4 momentum. Conservation of 4-momentum in particle decay. Collisions. The Newtonian limit

Appropiate books

† D. Gregory Classical Mechanics Cambridge University Press 2006

G.F.R Ellis and R-M Williams Flat and Curved Space-times. Oxford University Press 2000

A.P French and M.G Ebison Introduction to Classical Mechanics Klnwer 1986

M.A Lunn A First Course in Mechanics. Oxford University Press 1991

P.J. O'Donnell Essential Dynamics and Relativity CRC Press 2015

W. Rindler Introduction to Special Relativity Oxford University Press 1991

E.F Taylor and J.A Wheeler Spacetime Physics: Introduction to special relativity. Freeman 1992