PHYSICS 232 – CHAPTER 37: RELATIVITY

Time dilation:
\[ \Delta t = \frac{\Delta t_o}{\sqrt{1 - u^2/c^2}} = \gamma \Delta t_o, \quad \gamma = \frac{1}{\sqrt{1 - u^2/c^2}} \]

Length contraction:
\[ l = \frac{l_o}{\gamma} \]

Lorentz transformation
\[ x' = \gamma(x - ut), \quad y' = y, \quad z' = z, \quad t' = \gamma(t - ux/c^2) \]

Addition of velocities:
\[ v' = \frac{v - u}{1 - uv/c^2}, \quad v = \frac{v' + u}{1 + uv'/c^2} \]

Doppler effect: for a source emitting wave of frequency \( f_o \) as it moves toward the observer with speed \( u \), the received frequency is
\[ f = \sqrt{\frac{c + u}{c - u}} f_o \]

Momentum:
\[ \vec{p} = \gamma m \vec{v} \]

Total energy:
\[ E = \sqrt{m^2 c^4 + p^2 c^2} = \gamma mc^2 \]

Kinetic energy:
\[ K = E - mc^2 = (\gamma - 1)mc^2 \]

For \( v \ll c \) (non-relativistic body),
\[ K \approx \frac{1}{2} mv^2 \]