# Relativity Assignment – I

**2-1.1** By direct application of the Lorentz transformation equations, show that Eq. 2-1.1 is transformed into Eq. 2-1.2.

**2-1.2** By taking differentials of the Lorentz transformation equations, show that the quantity $ds$ transforms to $ds'$, where $ds^2 = dx^2 + dy^2 + dz^2 - c^2dt^2$, and $ds'^2 = dx'^2 + dy'^2 + dz'^2 - c^2dt'^2$.

**2-2.1** Two light bulbs in the laboratory, one at $x = 0$ and the other at $x = 10$ km, are set to flash simultaneously at $t = 0$. Observers on a magic carpet moving in the $+x$ direction with speed $3 \times 10^7$ m/sec observe the flashes. (a) What time interval do they note between flashes? (b) Which bulb do they say goes off first? [(a) $3.34 \times 10^{-9}$ sec (b) the bulb at 10 km]

**2-2.2** A long straight rod is inclined at angle $\theta$ to the $x$ axis. The rod moves in the $y$ direction with velocity $V$. (a) Find the velocity $v$ with which the point of intersection of the rod and the $x$-axis moves along the $x$ axis. (b) If $V = 10^{10}$ cm/sec, and $\theta = 0.10$ rad, what is the numerical value of $v$? (c) Does your result contradict the relativistic demand that $c$ is a limiting speed for all material particles? [(a) $v = V \cot \theta$ (b) $10^{11}$ cm/sec (c) no, for the point of intersection of the ruler with the $x$ axis is a mathematical point rather than a material particle.]

**2-4.2** A vector represented in coordinate form in the primed frame is given as $8\ \mathbf{1}_{x'} + 6\ \mathbf{1}_{y'}$. Find its representation in the unprimed frame, if the primed frame moves at $\mathbf{V} = 0.75c\ \mathbf{1}_x$ with respect to the unprimed frame. [$5.3\ \mathbf{1}_x + 6\ \mathbf{1}_y$]

**2-4.3** A thin rod of length $L_0$ when measured by a proper observer is moving at $0.75c$ with respect to a second observer in a direction at 37° to its own length. What is the length $L$ of the rod as measured by the second observer and his assistants? [$0.8\ L_0$]