Midterm Exam: Formulae from Weeks 1 –– 7

$$\beta \equiv \frac{v}{c} \qquad \gamma \equiv \frac{1}{\sqrt{1-\beta^2}}$$

$$t' = \gamma(t - \beta x/c) \qquad x' = \gamma(x - \beta t\, c) \qquad y' = y \qquad z' = z$$

$$t = \gamma(t' + \beta x'/c) \qquad x = \gamma(x' + \beta t'\, c) \qquad y = y' \qquad z = z'$$

$$\Lambda^{\mu}_{\nu} \equiv \begin{pmatrix} \gamma & -\gamma\beta & 0 & 0 \\ -\gamma\beta & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \qquad d\tau = \frac{dt}{\gamma_u} \qquad \gamma_u = \frac{1}{\sqrt{1-(u/c)^2}}$$

$$x^{\mu} \equiv (ct, x, y, z) \qquad \eta^{\mu} \equiv \frac{dx^{\mu}}{d\tau} = \gamma_u \left(c, u_x, u_y, u_z\right) \qquad p^{\mu} \equiv m_0 \eta^{\mu} = \left(\frac{E}{c}, p_x, p_y, p_z\right)$$

$$I = (c\Delta\tau)^2 = (c\Delta t)^2 - (\Delta x)^2 - (\Delta y)^2 - (\Delta z)^2 \qquad a^{\mu} \cdot b^{\mu} = a^0 b^0 - a^1 b^1 - a^2 b^2 - a^3 b^3$$

$$\frac{f'}{f} = \sqrt{\frac{1-\beta}{1+\beta}} \qquad E_{\gamma} = hf \qquad u_x = \frac{u'_x + v}{1 + u'_x v/c^2} \qquad u_{y,z} = \frac{u'_{y,z}}{\gamma\left(1 + u'_x v/c^2\right)}$$

$$\vec{F} = \frac{d\vec{p}}{dt} \qquad E = \sqrt{(pc)^2 + (m_0 c^2)^2} \qquad W = \int \vec{F} \bullet d\vec{l} = \Delta E$$

$$KE = E - m_0 c^2 \qquad m = \gamma m_0 \qquad \vec{p} = \gamma m_0 \vec{v} \qquad E = \gamma m_0 c^2 \qquad \beta = \frac{pc}{E}$$

$$E = m_{\text{inertial}} c^2 \qquad \vec{p} = m_{inertial}\vec{v} \qquad m_{inertial} = \gamma m_0 \qquad p_{\gamma} = \frac{E_{\gamma}}{c}$$

$$(1+\varepsilon)^n \approx 1 + n\varepsilon \qquad \sin\varepsilon \approx \varepsilon \qquad \cos\varepsilon \approx 1 - \frac{\varepsilon^2}{2} \qquad e^{\varepsilon} \approx 1 + \varepsilon \qquad \ln(1+\varepsilon) \approx \varepsilon$$

θ	$\sin\theta$	$\cos\theta$	$\tan\theta$
0°	0	1	0
30°	$1/2$	$\sqrt{3}/2$	$1/\sqrt{3}$
45°	$1/\sqrt{2}$	$1/\sqrt{2}$	1
60°	$\sqrt{3}/2$	$1/2$	$\sqrt{3}$
90°	1	0	∞