Ph 429 Reference Frames Paradigm Spring 2006

FINAL EXAM – April 24, 2006 7:30 pm - 9:20 pm

This exam is closed book and closed notes except for the information on this cover sheet. You may use a calculator and a ruler. Please do all your work in the blue books. **Only the blue books will be graded! Show all your work.**

Budget your time wisely! Not all questions are of equal difficulty.

Equations that may be useful:

$$\vec{\mathbf{a}}_{\text{rel}} = \vec{\mathbf{a}} - 2\vec{\boldsymbol{\omega}}\times\vec{\mathbf{v}}_{\text{rel}} - \vec{\boldsymbol{\omega}}\times\left(\vec{\boldsymbol{\omega}}\times\vec{\mathbf{r}}\right)$$

$$\vec{\boldsymbol{\omega}} = \Omega\hat{\mathbf{z}} \qquad \hat{\mathbf{z}} = \cos\theta\,\hat{\mathbf{r}} - \sin\theta\,\hat{\boldsymbol{\theta}} \qquad \lambda = \frac{\pi}{2} - \theta$$

$$x' = \gamma\left(x - vt\right) = x\cosh\beta - ct\sinh\beta \qquad x = \gamma\left(x' + vt'\right) = x'\cosh\beta + ct'\sinh\beta$$

$$ct' = \gamma\left(ct - \frac{v}{c}x\right) = ct\cosh\beta - x\sinh\beta \qquad ct = \gamma\left(ct' + \frac{v}{c}x'\right) = ct'\cosh\beta + x'\sinh\beta$$

$$x^2 - c^2t^2 = x'^2 - c^2t'^2$$

$$\frac{v}{c} = \tanh\beta \qquad \gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = \cosh\beta \qquad \frac{v}{c}\gamma = \sinh\beta$$

$$\tanh\left(\alpha+\beta\right) = \frac{\tanh\alpha + \tanh\beta}{1+\tanh\alpha\tanh\beta} \qquad \frac{u}{c} = \tanh\alpha \;\Rightarrow\; \frac{w}{c} = \tanh\left(\alpha+\beta\right) = \frac{\frac{u}{c}+\frac{v}{c}}{1+\frac{uv}{c^2}}$$

$$E = \gamma mc^2 = mc^2\cosh\beta \qquad p = \gamma mv = mc\sinh\beta$$

$$E^2 - p^2c^2 = m^2c^4 = E'^2 - p'^2c^2$$

$$E'_x = E_x \qquad E'_y = \gamma\left(E_y - vB_z\right) \qquad E'_z = \gamma\left(E_z + vB_y\right)$$

$$B'_x = B_x \qquad B'_y = \gamma\left(B_y + \frac{v}{c^2}E_z\right) \qquad B'_z = \gamma\left(B_z - \frac{v}{c^2}E_y\right)$$

$$\vec{\mathbf{E}}\cdot\vec{\mathbf{B}} = \vec{\mathbf{E}}'\cdot\vec{\mathbf{B}}' \qquad \left|\vec{\mathbf{E}}\right|^2 - c^2\left|\vec{\mathbf{B}}\right|^2 = \left|\vec{\mathbf{E}}'\right|^2 - c^2\left|\vec{\mathbf{B}}'\right|^2$$