Homework Set #2

(Homework Problems for Chapter 2)

1. Consider the parameters for two linear collider projects shown in the table (next page). Please complete the table by computing σ_x^* / σ_y^*, beam power, and luminosity.

2. Show that the phase space coordinates (x, x') of a particle change from $(x, x')_i$ to $(x, x')_f$ as follows:

$$\begin{pmatrix} x \\ x' \end{pmatrix}_f = \begin{pmatrix} 1 & \ell \\ 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ x' \end{pmatrix}_i ; \quad \text{for a free space length of } \ell$$

$$\begin{pmatrix} x \\ x' \end{pmatrix}_f = \begin{pmatrix} 1 & 0 \\ -1/F, & 1 \end{pmatrix} \begin{pmatrix} x \\ x' \end{pmatrix}_i ; \quad \text{for a lens of focal length F.}$$

Note that the determinants of the matrices of the transformation are both unity. Show that the emittance as defined in Eq. (2.11) does not change under the above changes.

3. Verify that the solutions of Eq. (2.25) can be represented as in Eq. (2.26) with β determined by Eq. (2.27).

Beam Parameters

	TESLA	NLC
CM Energy (GeV)	500	500
RF Frequency (GHz)	1.3	11.4
Linac rep rate (Hz)	5	120
# bunches/pulse	2820	190
# particles/bunch (10^{10})	2	0.75
Emittances $\gamma\varepsilon_x/\gamma\varepsilon_y$ $(10^{-6}$ m-rad)	10/0.03	4/0.07
$\beta_x^*\big/\beta_y^*$ (mm)	15/0.4	8/0.125
Bunch length σ_z (μm)	300	125
H_D	1.6	1.4
Beam size $\sigma_x^*\big/\sigma_y^*$ (nm)		
Beam power (MW)		
Luminosity $(10^{33}$ cm^{-2}s$^{-1})$		