Homework

[1] Derive the emission current per unit area from thermionic cathode. The cathode is a metal with work function ϕ and temperature T. Use the following formula if necessary.

$$\frac{1}{\alpha}\ln(1+e^{\alpha x+\beta})=\int\frac{dx}{1+e^{-\alpha x-\beta}} \quad (1)$$

[2] What is the bunch length at the gun exit to extract ILC bunch (3.2nC) with the following gun parameters;

V_A=200kV

d=5cm

S(cathode area)=0.79cm^2

[3] What is beta and gamma of the beam at the gun exit.

[4] What is the energy spread due to the thermal energy of the cathode. Please consider only z component.

[5] The bunch length is too large for RF acceleration with 1.3 GHz and we need bunching. Please choose the RF for bunching and explain the reason.
(a) 650MHz (b) 325MHz (c) 162.5MHz

[6] Derive the matrix element R_{56} for velocity bunching with linear approximation.

[7] Consider velocity bunching with SHB RF cavity of frequency chosen in [5]. Maximum RF voltage is 100kV. What is the distance of next RF cavity from the SHB cavity for perfect bunching?

[8] What is the expected bunch length after bunching in the linear approximation?

[9] In reality, the RF has a non-linear component. If up to third-order component is included, what is the expected bunch length after bunching?

[10] Normalized positron yield with 4 GeV electron beam is 0.2. How much electron intensity (bunch charge) is necessary to generate CLIC positron bunch (0.9nC).

[11] How much drive beam energy is required to generate positron with undulator (K=1.0, $\lambda_{undulator}$=1.0cm)? The first harmonic cut off energy has to be more than 10 MeV to generate positron.

[12] How much drive beam energy is required to generate positron with laser Compton (λ_{laser}=1.0μm)? The first harmonic cut off energy has to be more than 10 MeV to generate positron.