1. The explicit form of the electric field is (we can always choose the polar axis such that the trailing particle locates at $\theta = 0$ and consequently $x = r$)

$$E_\theta = 0 \ , \tag{1}$$

$$E_z = -\frac{q}{4\pi\varepsilon_0}\frac{s}{\gamma^2\left(s^2 + r^2/\gamma^2\right)^{3/2}} \ , \tag{2}$$

and

$$E_r = -\frac{q}{4\pi\varepsilon_0}\frac{r}{\gamma^2\left(s^2 + r^2/\gamma^2\right)^{3/2}} \ . \tag{3}$$

Since Coulomb field is divergent at the location of the leading particle, we will not consider the field at $s = x = 0$, and therefore it follows

$$\lim_{\gamma\to\infty} E_z = 0 \ , \tag{4}$$

$$\lim_{\gamma\to\infty} E_r = \frac{q}{4\pi\varepsilon_0}\lim_{\gamma\to\infty}\frac{r}{\gamma^2\left(s^2 + r^2/\gamma^2\right)^{3/2}} = \begin{cases} \infty & \text{for } s = 0 \\ 0 & \text{otherwise} \end{cases} \ . \tag{5}$$

Now we integrate eq. (5) from $-\infty$ to ∞ to get

$$\begin{aligned} \int_{-\infty}^{\infty}\lim_{\gamma\to\infty} E_r ds &= \frac{q}{4\pi\varepsilon_0}\lim_{\gamma\to\infty}\int_{-\infty}^{\infty}\frac{rds}{\gamma^2\left(s^2 + r^2/\gamma^2\right)^{3/2}} \\ &= \frac{q}{4\pi\varepsilon_0}\lim_{\gamma\to\infty}\frac{r}{\gamma^2}\int_{-\infty}^{\infty}\frac{ds}{\left(s^2 + r^2/\gamma^2\right)^{3/2}} \\ &= \frac{q}{4\pi\varepsilon_0 r}\lim_{\gamma\to\infty}\int_{-\infty}^{\infty} d\,\frac{s}{\left(s^2 + r^2/\gamma^2\right)^{1/2}} \\ &= \frac{q}{2\pi\varepsilon_0 r} \end{aligned} \ . \tag{6}$$

From eq. (5) and eq. (6), it follows that

$$\int_{-\infty}^{\infty}\lim_{\gamma\to\infty}\left[\frac{2\pi\varepsilon_0 r}{q}E_r\right]ds = 1 \ , \tag{7}$$

and

$$\lim_{\gamma\to\infty}\left[\frac{2\pi\varepsilon_0 r}{q}E_r\right]=\begin{cases}\infty & \text{for } s=0\\ 0 & \text{otherwise}\end{cases} \quad . \tag{8}$$

Eq. (7) and (8) coincide with the definition of Dirac Delta function and hence

$$\lim_{\gamma\to\infty}\left[\frac{2\pi\varepsilon_0 r}{q}E_r\right]=\delta(s) \ , \tag{9}$$

or equivalently

$$\lim_{\gamma\to\infty}E_r=\frac{q}{2\pi\varepsilon_0 r}\delta(s) \ . \tag{10}$$

Combining eq. (1), eq. (4) and eq. (10), we obtain

$$\lim_{\gamma\to\infty}\vec{E}=\frac{q\hat{r}}{2\pi\varepsilon_0 r}\delta(s) \ . \tag{11}$$

2. The longitudinal impedance is defined as

$$Z_{//}(\omega)=\frac{1}{c}\int_0^\infty w_{//}(s)e^{i\omega s/c}ds \ . \tag{12}$$

Taking the complex conjugate of eq. (12) and noticing that

$$w_{//}^*(s)=w_{//}(s) \ , \tag{13}$$

it follows that

$$Z_{//}^*(\omega)=\frac{1}{c}\int_0^\infty w_{//}(s)e^{-i\omega s/c}ds=\frac{1}{c}\int_0^\infty w_{//}(s)e^{i(-\omega)s/c}ds=Z_{//}(-\omega) \ . \tag{14}$$

The transverse impedance is defined as

$$Z_\perp(\omega)=-\frac{i}{c}\int_0^\infty w_\perp(s)e^{i\omega s/c}ds \ . \tag{15}$$

Taking the complex conjugate of eq. (15) and noticing that

$$w_\perp^*(s)=w_\perp(s) \tag{16}$$

yield

$$Z_\perp^*(\omega)=\frac{i}{c}\int_0^\infty w_{//}(s)e^{-i\omega s/c}ds=-\left[-i\frac{1}{c}\int_0^\infty w_{//}(s)e^{i(-\omega)s/c}ds\right]=-Z_\perp(-\omega) \ . \tag{17}$$