Formula for calculating the inclusive $N(e,e')X$ cross sections
Prepared by T.-S. H. Lee (September 1, 2019)

For the inclusive process, $e(p_e) + N(p_N) \rightarrow e'(p'_e) + X$, the differential cross section is written as

$$\frac{d\sigma}{dE'_e d\Omega_{e'}}(Q^2, W) \ = \ \Gamma[\sigma_T(Q^2, W) + \epsilon\sigma_L(Q^2, W)], \tag{1}$$

where $Q^2 = -q^2$, $q = p_e - p'_e = (\omega_L, \mathbf{q}_L)$, $W = \sqrt{(p_N + q)^2}$, and

$$\Gamma \ = \ \frac{\alpha q_L^\gamma}{2\pi^2 Q^2}\frac{E'_e}{E_e}\frac{1}{1-\epsilon}. \tag{2}$$

Here, we have defined $\alpha = e^2/4\pi = 1/137$ and

$$q_L^\gamma \ = \ \frac{W^2 - m_N^2}{2m_N} \ , \tag{3}$$

$$\epsilon \ = \ [1 + \frac{2\mathbf{q}_L^2}{Q^2}\tan^2\frac{\theta_e}{2}]^{-1} \ , \tag{4}$$

where $\theta_e$ is the angle between the outgoing and incoming electrons, and $m_N$ is the nucleon mass.

The structure functions are defined by

$$W_1(Q^2, W) \ = \ \frac{q_L^\gamma}{4\pi^2\alpha}\sigma_T(Q^2, W) \tag{5}$$

$$W_2(Q^2, W) \ = \ \frac{q_L^\gamma}{4\pi^2\alpha}\frac{Q^2}{\mathbf{q}_L^2}[\sigma_T(Q^2, W) + \sigma_L(Q^2, W)]. \tag{6}$$

The ANL-Osaka structure functions $W_1(Q^2, W)$ and $W_2(Q^2, W)$ for $Q^2 = 1 - 3(\mathrm{GeV/c})^2$ and $W = 1080 - 2000$ MeV are presented on the webpage.

By using the above definitions, one can also get the following expessions:

$$\frac{d\sigma}{dE'_e d\Omega_{e'}}(Q^2, W) = \frac{\alpha^2}{4E_e^2\sin^4\frac{\theta_e}{2}}[W_2(Q^2, W)\cos^2\frac{\theta_e}{2} + 2W_1(Q^2, W)\sin^2\frac{\theta_e}{2}] \tag{7}$$