Quantum Field Theory
Exercises 7

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Feynman Rules

1. Given the QED Lagrangian density

$$\mathcal{L} = \bar{\Psi}\left[i\partial\!\!\!/ - m\right]\Psi + \frac{1}{2}A_\mu\left[\partial^2 g^{\mu\nu} - \left(1 - \frac{1}{\xi}\right)\partial^\mu\partial^\nu\right]A_\nu + \mathcal{L}_{\text{int}}\,, \tag{1}$$

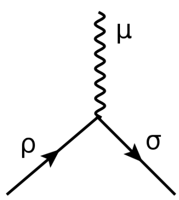
where

$$\mathcal{L}_{\text{int}} = -e\,\bar{\Psi}\gamma^\mu\Psi A_\mu\,, \tag{2}$$

construct the generating functional

$$Z[\eta,\bar{\eta},J] = \exp\left(i\int d^4w\mathcal{L}_{\text{int}}\,[\text{fields} \to \text{functional derivatives}]\right) \exp\left(i\int d^4xd^4y\bar{\eta}(x)\Delta(x-y)\eta(y)\right)\exp\left(\frac{i}{2}\int d^4xd^4yJ^\mu(x)\Delta_{\mu\nu}(x-y)J^\nu(y)\right)\,, \tag{3}$$

where $\Delta(x-y)$ and $\Delta_{\mu\nu}(x-y)$ are the electron and photon propagators, respectively, and derive the Feynman rule for the electron-electron-photon vertex



$$= \qquad ie\gamma^\mu_{\sigma\rho}\,.$$