1. $\frac{\delta j(x)}{\delta j(y)} = \delta(x-y)$, $S(\phi) = \int\ dx\left(\frac{1}{2}\partial_\mu\phi\partial^\mu\phi - \frac{1}{2}m^2\phi^2\right)$, $S(\phi) = S(\phi_0) + \int\ dx\frac{\delta S}{\delta\phi(x)}|_{\phi_0}(\phi(x) - \phi_0(x)) + \ldots.$

2. $\frac{\delta S}{\delta\phi(y)} = \int\ dx\left(\partial_\mu\phi\partial^\mu\frac{\delta\phi(x)}{\delta\phi(y)} - m^2\phi(x)\frac{\delta\phi(x)}{\delta\phi(y)}\right) = \int\ dx(\partial_\mu\phi\partial^\mu\delta(x-y) - m^2\phi(x)\delta(x-y))$

   $= -\partial^\mu\partial_\mu\phi(y) - m^2\phi(y)$

3. $Z_0(j) = e^{\frac{1}{2}\int dx\, dx' j(x)\Delta_F(x-x')j(x')}$, $\frac{\delta Z_0(j)}{\delta j(y)} = e^{\frac{1}{2}\int dx\, dx' j(x)\Delta_F(x-x')j(x')}\int dx\, dx' j(x)\Delta_F(x-x')\frac{\delta j(x')}{\delta j(y)} = Z_0(j)\int\ dx j(x)\Delta_F(x-y)$

4. $\frac{\delta^2 Z_0(j)}{\delta j(z)\delta j(y)} = \frac{\delta Z_0(j)}{\delta j(z)}\int\ dx\, j(x)\Delta_F(x-y) + Z_0(j)\int\ dx\,\delta(x-z)\Delta_F(x-y)$

   $= Z_0(j)\int\ dx\, j(x)\Delta_F(x-z)\int\ dx\, j(x)\Delta_F(x-y) + Z_0(j)\Delta_F(z-y)$

5. $\frac{\delta^2 Z_0(j)}{\delta j(z)\delta j(y)}|_{j=0} = \Delta_F(z-y)$

6. $\mathcal{L}_i = e^{\mu\phi}$

1. $<q',t'|q,t>=\prod_{n=0}^{n=N}\int dq_n\sqrt{\frac{m}{2\pi\hbar i\varepsilon}}e^{\frac{i}{\hbar}\varepsilon\sum_{n=1}^{N}\left(\frac{1}{2}m\left(\frac{q_{n+1}-q_n}{\varepsilon}\right)^2-V(q_n)\right)}$, $t_n>t_{n-1}\ldots>t_0$

2. $\int_{q(t)=q}^{q(t')=q'}\mathcal{D}qe^{\frac{i}{\hbar}\int d\tau L(q,\dot{q})}q(\tau_1)q(\tau_2)$

3. $<q',\ t'|\hat{q}(\tau_1)\hat{q}(\tau_2)|q,\ t\ >\ =<q',\ t'|\hat{q}(\tau_1)|q(\tau_1),\ \tau_1\ >\ <q(\tau_1),\ \tau_1|\hat{q}(\tau_2)|q,\ t\ >\ =$
$\int_{q(t)=q}^{q(t')=q'}\mathcal{D}qe^{\frac{i}{\hbar}\int d\tau L(q,\dot{q})}q(\tau_1)q(\tau_2)$ si $\tau_1>\tau_2$

4. $<q',t'|\hat{q}(\tau_2)\hat{q}(\tau_1)|q,t>=\int_{q(t)=q}^{q(t')=q'}\mathcal{D}qe^{\frac{i}{\hbar}\int d\tau L(q,\dot{q})}q(\tau_1)q(\tau_2)$, si $\tau_1<\tau_2$

5. $T\hat{q}(\tau_1)\hat{q}(\tau_2)=\theta(\tau_1-\tau_2)\hat{q}(\tau_1)\hat{q}(\tau_2)+\theta(\tau_2-\tau_1)\hat{q}(\tau_2)\hat{q}(\tau_1)$

6. $<q',t'|T\,\hat{q}(\tau_1)\hat{q}(\tau_2)|q,t>=\int_{q(t)=q}^{q(t')=q'}\mathcal{D}qe^{\frac{i}{\hbar}\int d\tau L(q,\dot{q})}q(\tau_1)q(\tau_2)$

7. $\psi(t)=U(t,t')\psi(t')$, $i\frac{\partial\psi}{\partial t}=H_I(t)\psi$,$i\frac{\partial U(t,t')}{\partial t}=\lambda\hat{H}_I(t)U(t,t')$

8. $U(t,t')=\sum_{n=0}\lambda^n U^{(n)}(t,t')$,$i\frac{\partial U^{(n+1)}(t,t')}{\partial t}=\hat{H}_I(t)U^{(n)}(t,t')$

9. $U^{(1)}(t,t')=-i\int_{t'}^{t}dt_1\hat{H}_I(t_1)$

10. $U^{(2)}(t,t')=(-i)^2\int_{t'}^{t}dt_2\hat{H}_I(t_2)\int_{t'}^{t_2}dt_1\hat{H}_I(t_1)$

11. $U(t,t')=T\exp\left(-i\int_{t'}^{t}dt_1\hat{H}_I(t_1)\right)$

1. $\frac{i^3}{3!} j(x_1)\Delta_F(x_1 - y_1) j(x_2)\Delta_F(x_2 - y_2) j(x_3)\Delta_F(x_3 - y_3)\kappa^{(3)}(y_1, y_2, y_3) = W^{(3)}$
2. $G_c^{(3)}(x_1, x_2, x_3) = \Delta_F(x_1 - y_1)\Delta_F(x_2 - y_2)\Delta_F(x_3 - y_3)\kappa^{(3)}(y_1, y_2, y_3)$
3. $\phi_c^{(3)}(x) = \frac{\delta W^{(3)}[j]}{i\,\delta j(x)} = \frac{i^2}{2!}\Delta_F(x - y_1) j(x_2)\Delta_F(x_2 - y_2) j(x_3)\Delta_F(x_3 - y_3)\kappa^{(3)}(y_{1,2}, y_3)$

Parámetros de Feynman:

$$\frac{1}{a} = \int_0^\infty dt\, e^{-at} \qquad \frac{1}{a}\frac{1}{b} = \int_0^\infty dt_1 \mathrm{dt}_2\, e^{-(a t_1 + b t_2)}$$

$$\frac{d^dk}{(2\pi)^d}\frac{1}{k^2 + m^2}\frac{1}{(k+p)^2 + m^2} = \int_0^\infty dt_1 \mathrm{dt}_2 \frac{d^dk}{(2\pi)^d} e^{-(a t_1 + b t_2)} \quad a = k^2 + m^2, b = (k+p)^2 + m^2$$

Trazas

1. $\{\gamma^\mu, \gamma^\nu\} = 2\eta^{\mu\nu}$
2. $\frac{1}{2}(\mathrm{Tr}(\gamma_\mu\gamma_\nu) + \mathrm{Tr}(\gamma_\nu\gamma_\mu)) = \delta_{\mu\nu}\mathrm{Tr}(1) = 4\delta_{\mu\nu} = \mathrm{Tr}(\gamma_\mu\gamma_\nu)$
3. $\mathrm{Tr}(\gamma_\mu\gamma_\nu\gamma_\alpha\gamma_\beta) = \mathrm{Tr}(S\gamma_\mu\gamma_\nu\gamma_\alpha\gamma_\beta S^{-1}) = \mathrm{Tr}(S\gamma_\mu S^{-1}S\gamma_\nu S^{-1}S\gamma_\alpha S^{-1}S\gamma_\beta S^{-1}) = L^{-1}{}^\mu_{\bar\mu} L^{-1}{}^\nu_{\bar\nu}$

   $L^{-1}{}^\alpha_{\bar\alpha} L^{-1}{}^\beta_{\bar\beta}\mathrm{Tr}\big(\gamma^{\bar\mu}\gamma^{\bar\nu}\gamma^{\bar\alpha}\gamma^{\bar\beta}\big)$
4. $S\,\gamma^\mu\,S^{-1} \equiv L^{-1}{}^\mu_\nu\gamma^\nu$
5. $\mathrm{Tr}\big(\gamma^{\bar\mu}\gamma^{\bar\nu}\gamma^{\bar\alpha}\gamma^{\bar\beta}\big) = A\eta^{\mu\nu}\eta^{\alpha\beta} + B\eta^{\mu\alpha}\eta^{\nu\beta} + C\eta^{\mu\beta}\eta^{\alpha\nu} = A\eta^{\beta\mu}\eta^{\nu\alpha} + B\eta^{\beta\nu}\eta^{\mu\alpha} + C\eta^{\beta\alpha}\eta^{\nu\mu}$, $A = C$
6. $\mathrm{Tr}(\gamma^{\bar\mu}\gamma^{\bar\nu}\gamma^\alpha\gamma_\alpha) = A\eta^{\alpha\mu}\eta^\nu_\alpha + B\eta^{\alpha\nu}\eta^\mu_\alpha + A4\eta^{\nu\mu} = A\eta^{\mu\nu} + B\eta^{\mu\nu} + 4A\eta^{\mu\nu}$
7. $\gamma^\alpha\gamma_\alpha = \eta_{\alpha\beta}\gamma^\alpha\gamma^\beta = \frac{1}{2}\eta_{\alpha\beta}\{\gamma^\alpha, \gamma^\beta\} = \frac{1}{2}\eta_{\alpha\beta}2\eta^{\alpha\beta} = 4$
8. $\mathrm{Tr}(\gamma^{\bar\mu}\gamma^{\bar\nu}\gamma^\alpha\gamma_\alpha) = 4\times 4\eta^{\mu\nu} = (5A + B)\eta^{\mu\nu}$, $5A + B = 16$
9. $\mu = \nu = \alpha = \beta = 0$,$4 = 2A + B$,$3A = 12$,$A = 4$, $B = -4$
10. $\mathrm{Tr}(\gamma^\mu\gamma^\nu\gamma^\alpha\gamma^\beta) = 4\eta^{\beta\mu}\eta^{\nu\alpha} - 4\eta^{\beta\nu}\eta^{\mu\alpha} + 4\eta^{\beta\alpha}\eta^{\nu\mu}$
11. $\mathrm{Tr}(\gamma^5\gamma^\mu\gamma^\nu\gamma^\alpha\gamma^\beta) = A\epsilon^{\mu\nu\alpha\beta}$,$\gamma^5 = i\gamma^0\gamma^1\gamma^2\gamma^3$, $\mathrm{Tr}(\gamma^5\gamma^0\gamma^1\gamma^2\gamma^3) = -4i = A$