

40 POINTS

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**Homework Assignment III**

(5)

**Problem 1:** In the SM, we have the weak Isospin triplet of currents:

$$\vec{J}_M = \bar{L} \gamma_M \frac{\vec{T}}{2} L, \text{ where } L = \begin{pmatrix} \nu \\ e^- \end{pmatrix}_L$$

and the Isospin singlet current, the weak hypercharge:

$$J_M^Y = -2 \bar{R} \gamma_M R - \bar{L} \gamma_M L$$

where

$$Q = T^3 + Y/2; \text{ recall that: } \begin{cases} Y = -1 \text{ for } L \\ Y = -2 \text{ for } R \end{cases}$$

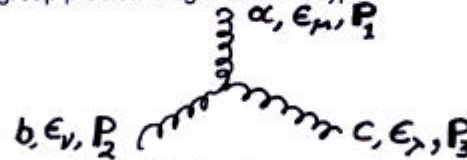
Show that the couplings to  $Z^0$  can be written as:

$$J_M^Z = J_M^3 - \sin^2 \theta_W J_M^{em}$$

$$J_M^{em} = J_M^3 + 1/2 J_M^Y; \text{ Next include } \mu^-, \tau^-$$

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**Problem 2:** Show that a non-abelian theory based on an SU(N) symmetry group predicts diagrams of the type:



which correspond to the following Feynman rules:

$$-ig f_{abc} \left\{ g_{\mu\nu} (P_1 - P_2)_\lambda + g_{\nu\lambda} (P_2 - P_3)_\mu + g_{\lambda\mu} (P_3 - P_1)_\nu \right\}$$

This would be the ggg coupling in QCD or the  $Z^0 W^+ W^-$  coupling in the W.S model

For those of you who have time/motivation: calculate the diagram for ggg in QCD