5. Higgs Phenomenology

1. Higgs Decays

(i) Compute the rate for $h \to f\bar{f}$. Express your answer in terms of the Higgs mass, the fermion mass, and v. You can find the relevant vertex on page 716 of P & S.

(ii) Compute the rate for $h \to W^+W^-$. Express your answer in terms of the Higgs mass, the W mass, and v. Obtain the result for $h \to ZZ$.

(iii) Use your results to estimate the width of the Higgs if $m_h = 100, 200, 400$ GeV. Refer to the PDG to get any masses you need.

2. A More Complicated Decay

Compute the decay $h \to \gamma\gamma$. Express your answer in terms of α, m_h, and v. *Hints:* This decay must occur via a charged loop. Argue that the loop must be finite. Assume that the top quark dominates this loop (actually a W loop is also important). Don't forget that you have identical particles in the final state, there is a minus sign due to the fermion loop, and colour factors. The Feynman parameter integral is a bear, so simplify it by considering the limit $m_t \to \infty$ at the appropriate point. The form of the effective $h\gamma\gamma$ vertex you get should look like $i\kappa(g^{\mu\nu}k \cdot k' - k^\mu k'^\nu)$ where k and k' are the momenta of the outgoing photons. The constant κ will emerge from your loop calculation.

3. Higgs contribution to the anomalous magnetic moment of the muon

Compute the contribution of the Higgs particle to the anomalous magnetic moment of the muon. *Hints:* Read sections 6.2 and 6.3 of Peskin & Schroeder. You will need to compute $F_2(q^2 = 0)$, which is finite. You can leave your result in terms of the Feynman parameter integral (or better, obtain the approximate answer for $m_h >> m_\mu$).