Problem C8.1 Compute the imaginary part of the function $B(p^2, m^2)$ for $p^2 > 4m^2$.

Problem H8.1 Consider one Hermitean scalar field in with the Lagrangian

$$\mathcal{L} = \frac{1}{2}\partial_\mu\varphi\partial^\mu\varphi - \frac{1}{2}m_B^2\varphi^2 - \frac{1}{6}g_B\varphi^3,$$

but now in $d = 6$ space-time dimensions.

(a) At order g_B^2 there are several diagrams contributing to the selfenergy. Compute the 1-PI diagram (the one without tadpole), except for one remaining integral over a Feynman parameter. Write $d = 6 - 2\varepsilon$, and perform a Laurent series expansion around $\varepsilon = 0$, up to order ε^0.

(b) Expand the selfenergy $\Pi(p^2)$ around $p^2 = m_R^2$ to second order,

$$\Pi(p^2) = \Pi(m_R^2) + (p^2 - m_R^2)\Pi'(m_R^2)$$

and explicitely compute $\Pi(m_R^2)$ and $\Pi'(m_R^2)$. Express your results in terms of the dimensionless integrals

$$c_n = \int_0^1 dx\,[1 - x(1-x)]^n \ln[1 - x(1-x)]$$

which you do not need to evaluate further.

(c) Determine the relation between the bare mass m_B and the renormalized mass m_R, as well as the wave function renormalization factor Z.