Homework 2

Spectral functions and Green's functions in a perturbative expansion in U to second order in U.

1) Consider the symmetric ($\epsilon_f = -\frac{U}{2}$) Anderson impurity model:

$$H = \sum_{k\sigma} \epsilon_k c^\dagger_{k\sigma} c_{k\sigma} + \sum_{k\sigma} (V_k c^\dagger_{k\sigma} f_\sigma + V_k^* f^\dagger_\sigma c_{k\sigma}) + \epsilon_f (n_\uparrow + n_\downarrow) + U n_\uparrow n_\downarrow$$

Take the gybridization function

$$\Delta(i\omega_n) = \sum_k \frac{|V_k|^2}{i\omega_n - \epsilon_k} = -i\Gamma \mathrm{sign}\omega_n$$

where $\Gamma = V^2\rho = 1$ and $epsilon_f$=-U/2.

1) Evaluate numerically the Matsubara Green's function $G(\tau)$ and plot it at $\beta = 1$, 1/10 and 1/50 at $U = 2$.

2) Evaluate numerically the $T = 0$ spectral function and plot it for $U = .5$, 1, 1.5, 2, and 3.

Carry out the calculation for parts 1 and 2 in two schemes:

a) bare perturbation $\Sigma = \Sigma(G^0, U)$

a) self-consistent perturbation theory $\Sigma = \Sigma_{skel}(G, U)$.

3) Derive an expression for the spectral function at finite temperatures and evaluate it for the same parameters as in part 2.