Waves and Phase Transitions in Spin Systems (10.0 points)

Part A. Spin precession and interactions (1.2 points)

A.1 (0.3 pt)

$\gamma =$

A.2 (0.4 pt)

$\omega_L =$

A.3 (0.5 pt)

$J_0 =$

Part B. Spin Waves (4.5 points)

B.1 (0.3 pt)

$\vec{B}_{i,\text{eff}} =$

B.2 (0.3 pt)

$\frac{d\vec{S}_i}{dt} =$

B.3 (2.0 pt)

$\omega(k) =$

B.4 (0.6 pt)

$m_{\text{eff}} =$

B.5 (1.3 pt)

$m_{\text{eff}} =$

Part C. Phase transitions in spin chains (4.3 points)

C.1 (0.5 pt)

$\frac{p_\uparrow}{p_\downarrow} =$

C.2 (1.0 pt)

$\bar{s} =$

Sketch for $h_o \gg k_B T$:

Sketch for $h_o \approx k_B T$:

Sketch for $h_o \ll k_B T$:

C.3 (0.2 pt)

$E_g =$

C.4 (0.2 pt)

$\tilde{J}_{\text{eff}}$ =

C.5 (1.2 pt)

Equation for $\bar{s}$:

$T_c =$

C.6 (1.0 pt)

When $T < T_c$ and $T_c - T \ll T_c$, the possible values of $\bar{s}$ are:

sketch of $\bar{s}$ as a function of T:

C.7 (0.2 pt)

Circle the right answer:

$T > T_c$: paramagnetic ferromagnetic

$T < T_c$: paramagnetic ferromagnetic