2.) the RC network has to supply a 180° phase shift to have positive feedback.

The RC network is simply a Norton divider with
impedance \( Z \). Then \( \text{Im} \ Z \) has to be zero (and
\( \text{Im} \ Z = \frac{\text{Im} \ V}{\text{Re} \ Z} \)) to get 180° phase shift.

Write down an expression for \( Z \) and set \( \text{Im} \ Z = 0 \).
This will give you the frequency.

Think of the RC network as:

\[
\begin{align*}
\text{In} & \quad \text{Out} \\
\text{R} & \quad \text{C} \\
\text{+} & \quad \text{W} \\
\text{1} & \quad \text{0}
\end{align*}
\]

so \( \text{Out}/\text{In} = \frac{Z}{2} \). \( Z = \frac{Z_c + RH(2 + RH)(Z_c + R)}{Z_c + RH}
\)
\( Z_c = -j/\omega C
\)

After a lot of algebra get:

\[
\frac{1}{\beta} = \frac{j}{\omega C} + \frac{1 - 4k^2}{k^3} \quad X = \omega RC
\]

or \( k = \frac{1}{\beta} \)
3. The gain \( G \) minimum gain required is \( \frac{1}{\beta} \).

Substitute \( \beta = \omega \frac{1}{L} \) into the next part.

Thus \( \frac{1}{\beta} = \frac{1}{\omega \frac{1}{L}} = \frac{1}{\omega L} \).

4. \( Z = \frac{1}{\beta} \)

Series Resonance is \( Z_{\text{min}} \)

so \( \omega L - \frac{1}{\omega C} = 0 \) \( \omega^2 = \frac{1}{L C} \).

Parallel Resonance is \( \frac{1}{Z} = 0 \)

so \( \omega L \omega C + \frac{1}{j (\omega L - \frac{1}{\omega C})} = 0 \) \( \omega^2 L = \frac{1}{\omega L - \frac{1}{\omega C}} = 0 \).

So \( \omega^2 L C_2 - \frac{1}{\omega C_2} - 1 = 0 \) \( \omega^2 = \frac{1}{\omega L - \frac{1}{\omega C}} = \frac{C_1 + C_2}{C_2 L} \).

Hence \( \Delta \omega^2 = \omega_{L}^2 - \omega_{p}^2 = \frac{1}{L C_1} \left(1 - \frac{C_1 + C_2}{C_2}ight) = \frac{1}{L C_1} \left(1 - 1 - \frac{C_1}{C_2}\right) \).
\[ \Delta(w_1) = \omega_0^2 - \omega_p^2 = \frac{1}{LC_1} \left( \frac{C_1}{C_2} \right) = \omega_0^2 \frac{C_1}{C_2} \]

\[ \omega_0 \approx \omega \]

Thus

\[ \Delta w = \frac{1}{2} \frac{C_1}{C_2} \]

5.) Must have \( V_\text{in} = V_\text{in}^+ \) before input, output is unlatched.

\[ \frac{V_\text{in}}{V_\text{out}} = \frac{R_i}{R_i + R_c} \quad \frac{V_\text{in}^+}{V_\text{out}^+} = \frac{2 \text{ (resonant)}}{8 + \frac{R}{2R_c}} = \frac{R}{2R_c} = \frac{1}{2} \]

So

\[ 2 = \frac{R_i}{R_i + R_c} = 1 + \frac{R_i}{R_c} \]

\[ \frac{R_i}{R_c} = 1 \]

\( \frac{R_i}{R_c} \) can be higher until the circuit latches.