5.3 STABILITY CONSIDERATIONS:

STABILITY:

Is the ability of an amplifier to maintain effectiveness in its nominal operating characteristics such as physical temperature, signal frequency, source & load coefficient etc.

STABILITY REQUIREMENT:

Stability then implies that the magnitudes of the reflection coefficients are less than unity.

$|\Gamma_L| < 1$, $|\Gamma_S| < 1$

$|\Gamma_{in}| = S_{11} + \left|\frac{S_{12}\, S_{21}\, \Gamma_L}{1 - S_{22}\, \Gamma_L}\right| < 1$

$|\Gamma_{out}| = S_{22} + \left|\frac{S_{12}\, S_{21}\, \Gamma_S}{1 - S_{11}\, \Gamma_S}\right| < 1$

TYPES OF STABILITY:

i) UNCONDITIONAL STABILITY:

A network is said to be "unconditionally stable" in a frequency range if:

$|\Gamma_{in}| < 1$ & $|\Gamma_{out}| < 1$

$|\Gamma_L| < 1$ & $|\Gamma_S| < 1$

ii) CONDITIONAL STABILITY:

A network is said to be "conditionally stable" or "potentially unstable" in a frequency range if:

$|\Gamma_{in}| < 1$ & $|\Gamma_{out}| < 1$

STABILITY CIRCLES:

i. Input stability circle
ii. Output stability circle

OUTPUT STABILITY CIRCLE:

In Fig 5.31, For output stability circle $|\Gamma_{in}| = 1$

$|\Gamma_{in}| = \left| S_{11} + \frac{S_{12} S_{21} \Gamma_L}{1 - S_{22} \Gamma_L} \right| = 1$

$\left| S_{11} (1 - S_{22} \Gamma_L) + S_{12} S_{21 \, \Gamma_L} \right| = |1 - S_{22} \Gamma_L|$

$|S_{11} - S_{11} S_{22} \Gamma_L + S_{12} S_{21} \Gamma_L| = |1 - S_{22} \Gamma_L|$

$|S_{11} - (S_{11} S_{22} - S_{12} S_{21}) \Gamma_L| = |1 - S_{22} \Gamma_L|$

$$S_{11} S_{22} - S_{12} S_{21} = \Delta$$

$|S_{11} - \Delta \Gamma_L| = |1 - S_{22} \Gamma_L|$

$|S_{11}| - \Delta |\Gamma_L| = 1 - |S_{22} \Gamma_L|$

$|S_{22} \Gamma_L|$ - $\Delta |\Gamma_L|$ = $1 - |S_{11}|$

$(S_{22} - \Delta) \, |\Gamma_L|$ = $1 - |S_{11}|$

Multiply ($S_{22}{}^{*}$ + Δ^{*}) both sides

$|\Gamma_L| \{(S_{22} - \Delta)\} \{(S_{22}{}^{*} + \Delta^{*})\} = \{1 - |S_{11}|\} \{(S_{22}{}^{*} + \Delta^{*})\}$

$|\Gamma_L| \{|S_{22}|^2 - |\Delta|^2\} = |S_{22}{}^{*}| + |\Delta^{*}| - |S_{11} S_{22}{}^{*}| - |S_{11} \Delta^{*}|$

$|\Gamma_L| \{|S_{22}|^2 - |\Delta|^2\} = |S_{22}{}^{*}| + \left| S_{11}{}^{*} S_{22}{}^{*} \right| - |S_{12}{}^{*} S_{21}{}^{*}| - |S_{11} S_{22}{}^{*}| - |S_{11} \Delta^{*}|$

$|\Gamma_L| = \frac{|S_{22}{}^{*}| + \left| S_{11}{}^{*} S_{22}{}^{*} \right| - |S_{12}{}^{*} S_{21}{}^{*}| - |S_{11} S_{22}{}^{*}| - |S_{11} \Delta^{*}|}{|S_{22}|^2 - |\Delta|^2}$

$|\Gamma_L| = \frac{|S_{22}{}^{*}| - |S_{12}{}^{*} S_{21}{}^{*}| - |S_{11} \Delta^{*}|}{|S_{22}|^2 - |\Delta|^2}$

$\left| \Gamma_L - \frac{|S_{22}{}^{*} - S_{11} \Delta^{*}|}{|S_{22}|^2 - |\Delta|^2} \right| = \left| \frac{S_{12} \, S_{21}}{|S_{22}|^2 - |\Delta|^2} \right|$

The equation for the output stability circle ($|\Gamma_{in}|$ =1) drawn in the Γ_L plane cab be written as,

$|\Gamma_L - C_L| = R_L$

$C_L = C_{out} = \frac{(S_{22} - S_{11}{}^{*} \Delta)^{*}}{|S_{22}|^2 - |\Delta|^2}$

$R_L = r_{out} = \left| \frac{S_{12} \, S_{21}}{|S_{22}|^2 - |\Delta|^2} \right|$

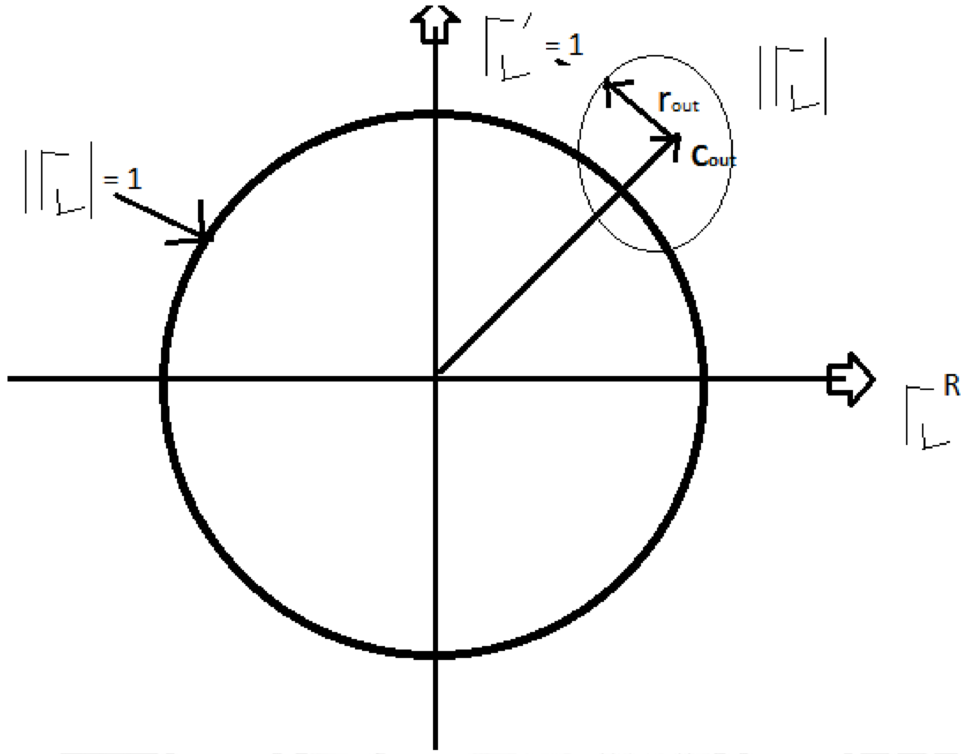

Fig: 5.3.1 Output stability circle

INPUT STABILITY CIRCLE:

In Fig 5.3.2, The input stability circle ($|\Gamma_{out}|$ =1) drawn in the Γ_S plane cab be written as,

$|\Gamma_S - C_S| = R_S$

$C_S = C_{in} = \frac{(S_{11} - S_{11}{}^{*}\Delta)^{*}}{|S_{11}|^2 - |\Delta|^2}$

$R_S = r_{in} = \left|\frac{S_{12}\ S_{21}}{|S_{11}|^2 - |\Delta|^2}\right|$

Special case: unconditional stability:

K= $\frac{1-|S_{11}|^2 - |S_{22}|^2 - |\Delta|^2}{2|S_{12}||S_{21}|}$ > 1

$|\Delta| = |S_{11}S_{22} - S_{12}S_{21}| < 1$

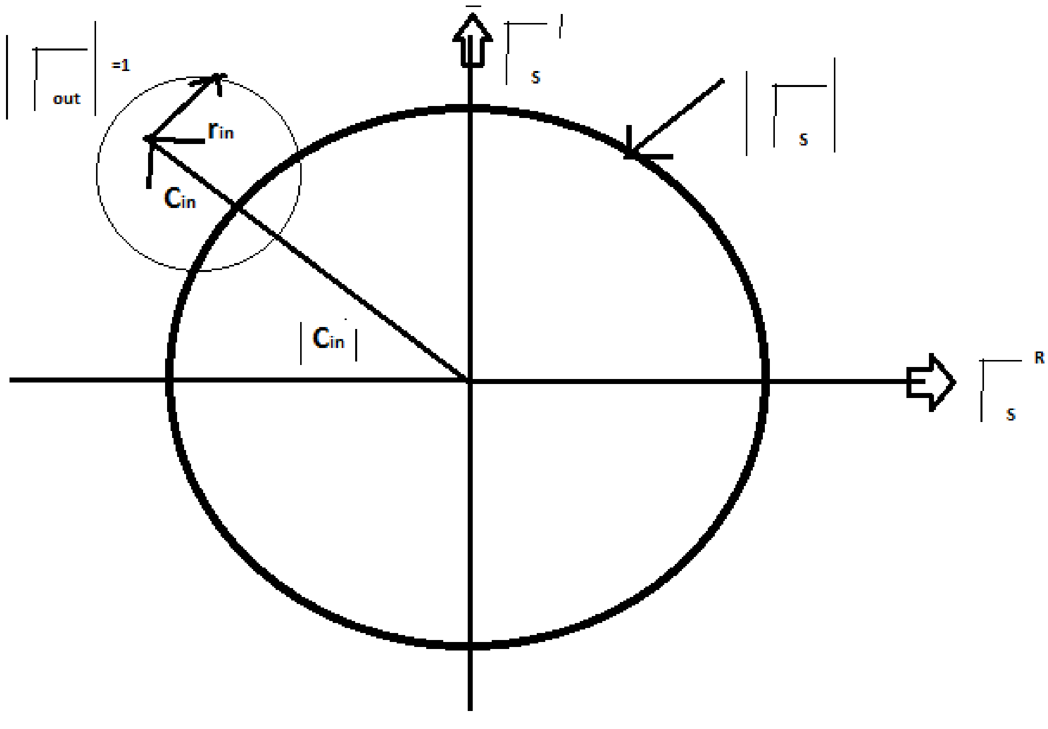

Fig: 5.3.2 Input stability circle