$k = 1.38x10^{-23}$ $\lambda = \frac{c}{f_c}$ (m) with $c = 3x10^8 m/s$

$T_e = T_o(F-1)$ with $T_o = 290^o$

$S_n(f) = \frac{N_0}{2} \forall f \quad N_0 = k(T_a + T_e)$

$$T_e = T_1 + \frac{T_2}{G_1} + \frac{T_3}{G_1 G_2}$$

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2}$$

$$G_{Ant} = \frac{4\pi A_{eff}}{\lambda^2}$$

For dish (*circular*) antenna $G_{Ant} = \left(\frac{\pi D}{\lambda}\right)^2$ D=Diameter(m)

Path Loss $= L_p = \left(\frac{4\pi r}{\lambda}\right)^2$ $r =$ distance (m)

$P_T =$ Tx Power: $G_T =$ Tx Ant Gain: $G_R =$ Rec Ant Gain

Received power = $P_R = \frac{P_T G_T G_R}{L_p}$

$$(S/N)_{Pre} = \frac{P_T G_T G_R}{L_M L_p k(T_a + T_e)B_e} = \frac{P_T G_T G_R}{L_M L_p k(T_a + T_o(F-1))B_e}$$

$(S/N)_{pre}$ (dB)=$P_T + G_T + G_R - L_M - L_p - 10\log(k(T_a + T_0(F-1)) - 10\text{Log}(B_e)$