# FORMÜL KAĞIDI

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**Low Frequency**: $\dfrac{S}{S+W_L}$  **High Frequency**: $\dfrac{W_H}{S+W_H}$

**Miller**

$(1-A).C\ ,\ (1-\frac{1}{A}).C$

**BJT**: $g_m = \dfrac{I_C}{V_T}$, $r_e = \dfrac{V_T}{I_E}$, $r_i = \dfrac{V_T}{I_B}$

**MOS**: $g_m = \sqrt{2\beta . I_D}$

$w_1 = w_2 = \dots = w_n \Rightarrow \dfrac{W_L}{\sqrt{2^{1/n}-1}}\ ,\ \sqrt{2^{1/n}-1}\,.W_H$

$w_1 \neq w_2 \neq \dots \neq w_n \Rightarrow W' = (w_1 \times w_2 \times \dots \times w_n)^{1/n}$

| Common Collector | Common Emitter | Common Base |
|---|---|---|
| $A = \dfrac{R_E // R_L}{r_e + R_E//R_L}$ | $A = -\dfrac{R_C//R_L}{r_e + R_E}$ | $A = \dfrac{R_C//R_L}{r_e}$ |
| $R_i = R_B // (\beta_F)(r_e + R_E//R_L)$ | $R_i = R_B // (\beta_F)(r_e + R_E)$ | $R_i = R_E // r_e$ |
| $R_o = R_E // (r_e + \dfrac{R_S//R_B}{\beta_F})$ | $R_o = R_C // r_o$ | |

| Common Drain | Common Source | Common Gate |
|---|---|---|
| $A = \dfrac{g_m.(R_S//R_L)}{1 + g_m(R_S//R_L)}$ | $A = \dfrac{-g_m(R_D//R_L)}{1 + g_m R_S}$ | $A = g_m.(R_D//R_L)$ |
| $R_i = R_G\ ,\ R_o = R_{SS}$ | $R_i = R_G\ ,\ R_o = R_D // r_o$ | $R_i = R_{SS}$ |

$F_T = \dfrac{g_m}{2\pi(C_{cb}+C_{be})}\ ,\ \dfrac{g_m}{2\pi(C_{dg}+C_{gs})}$

$F_{os} = \dfrac{1}{2\pi . R_s . C_s}\ ,\ F_{ps} = \dfrac{1}{2\pi . (R_s // 1/g_m) C_s}$

**THEVENIN** $R_{TH} = R_{B1} // R_{B2}\ ,\ V_{TH} = \dfrac{V_{DD}\,(V_C)}{R_{B1}+R_{B2}} . R_{B2}$

**MOS**

$|V_{GS}-V_T| \leq |V_{DS}|$ SATURATION: $I_D = \dfrac{\beta}{2}.(V_{GS}-V_T)^2$

$|V_{GS}-V_T| > |V_{DS}|$ LINEAR: $I_D = \dfrac{\beta}{2}\left(2(V_{GS}-V_T).V_{DS} - V_{DS}^2\right)$

## FEEDBACK

| INPUT / OUTPUT | V | I |
|---|---|---|
| V | $r_{if} = r_i(1-\beta A)$<br>$r_{of} = \left(1-\dfrac{r_i}{R_g+r_i}.\beta . A\right)^{-1}.r_o$ | $r_{if} = r_i(1-\beta A)^{-1}$<br>$r_{of} = \left(1-\dfrac{R_g}{r_i+R_g}.\beta A\right)^{-1}.r_o$ |
| I | $r_{if} = r_i(1-\beta A)$<br>$r_{of} = \left(1-\dfrac{r_i}{R_g+r_i}.\beta . A\right).r_o$ | $r_{if} = r_i(1-\beta A)^{-1}$<br>$r_{of} = \left(1-\dfrac{R_g}{r_i+R_g}.\beta A\right)^{-1}.r_o$ |

High Frequency: $A_f = \dfrac{A_0}{1-\beta_0 A_0} . \dfrac{(1-\beta_0 A_0)W_k}{jw + (1-\beta_0 A_0).W_k}$

$W_k' = (1-\beta_0 A_0).W_k \rightarrow K(S)$

Low Frequency: $W_k' = \dfrac{W_k}{(1-\beta_0 A_0)}$

$A_f = \dfrac{A}{1-\beta A}$  $LG \simeq \beta . A$

## PULSE RESPONSE

Rising time $\Rightarrow t_r = \dfrac{0.35}{f_{cst}}$

Tilt $\Rightarrow \delta = \dfrac{t_d}{RC}\ ,\ t_d = T/2$

$RC = C_1(r_i+R_g), C_2(r_o+R_y)$

## STABILITY

G.M < 0

P.M > 0

$|\beta A| < 1$

$P.M = \varphi = 180° - \left(\text{Arctg}\,\dfrac{f_0}{f_{k1}} + \text{Arctg}\,\dfrac{f_0}{f_{k2}} + \text{Arctg}\,\dfrac{f_0}{f_{k3}}\right)$

## PEAK

generally:

$S^2 + 2\xi w_0 S + w_0^2\ ,\ w_0^2 = (1-\beta A) S_{k1} . S_{k2}$

$*\ \xi_k = 1/\sqrt{2}$  $F_0 = \dfrac{w_0}{2\pi}\ ,\ \xi = \dfrac{-(S_{k1}+S_{k2})}{w_0}$

$\dfrac{F_P}{F_0} = \sqrt{1-2\xi}$  (peak value)$^2$ $M_T(dB) = 20 \log \dfrac{1}{2\xi\sqrt{1-\xi^2}}$

$F_{-3dB} = F_0 \sqrt{1-2\xi^2 + \sqrt{(1-2\xi^2)^2+1}}$

$S_{1,2} = -\xi w_0 \pm w_0\sqrt{\xi^2-1}\ ,\ S_1 = 10 S_2 \Rightarrow \xi = \sqrt{3}$

## NO PEAK

$1-\beta A_0 \leq \dfrac{(F_{k1}+F_{k2})^2}{2.F_{k1}.F_{k2}}\ ,\ \leq \dfrac{[F_3(F_1+F_2)+F_1F_2]^2}{2.F_1.F_2.F_3(F_1+F_2+F_3)}$

## COMPENSATION

$R_A = r_i + R_G$  $R_B = r_i // R_G \Leftarrow$ LC comp. if $f_k = f_i$ No F.B

$L_B = \dfrac{R_A . R_B^2 . C_i}{2r_i}$

$f_{ust} = \sqrt{2} f_k$

**LC Compensation**

$S^2 + \underbrace{aS}_{2\xi w_0} + \underbrace{b}_{w_0^2}\ ,\ \xi = \dfrac{1}{\sqrt{2}} \Rightarrow \left(\dfrac{a}{\sqrt{2}}\right)^2 = b$

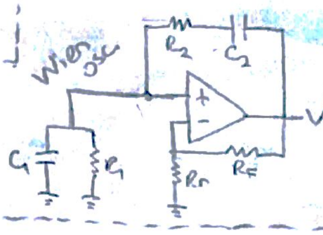
$W_{ust} = W_0$

# OSCILLATORS

$\beta A = 1$

$Q = 0$

RC TYPE



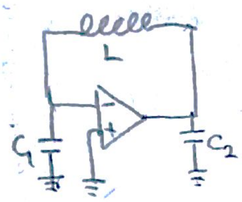

$\beta A = 1, Q = 0$

$V_o \Rightarrow W_o = \frac{1}{\sqrt{C_1C_2R_1R_2}}$ , $K_{vF} - 1 = \frac{C_1R_1 + C_2R_2}{C_2R_1}$

$K_{vF} = \frac{R_r + R_F}{R_F}$

LC TYPE

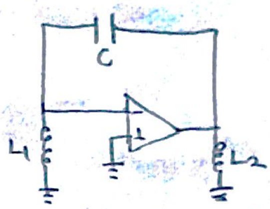
## ① Colpitts




$W_o^2 = \frac{C_1+C_2}{L.C_1.C_2} + \frac{1}{r_i r_o.C_1.C_2}$

$K_o = \frac{C_1}{C_2} + \frac{r_o}{r_i}.\frac{C_2}{C_1}$

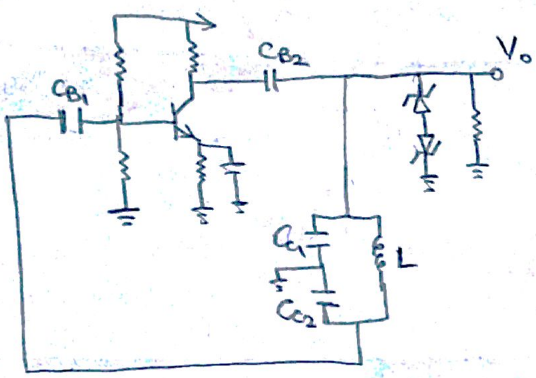
## ② Hartley




$W_o^2 = \frac{1}{C(L_1+L_2) + \frac{L_1.L_2}{r_i.r_o}}$

$K_o = \frac{L_2}{L_1} + \frac{r_o L_1}{r_i L_2}$

## Colpitts




$W_o^2 = \frac{1}{L.C_T}$ $C_T \cong C_{C1}$

$C_{C2} < K_o.C_{C1}$

$\left|\frac{1}{jwC_{B1,2}}\right|_{w=w_o} \cong 0$

$V_T = I_D.R_D$ (Diode) $I_c = C.\frac{\Delta V}{\Delta t}$